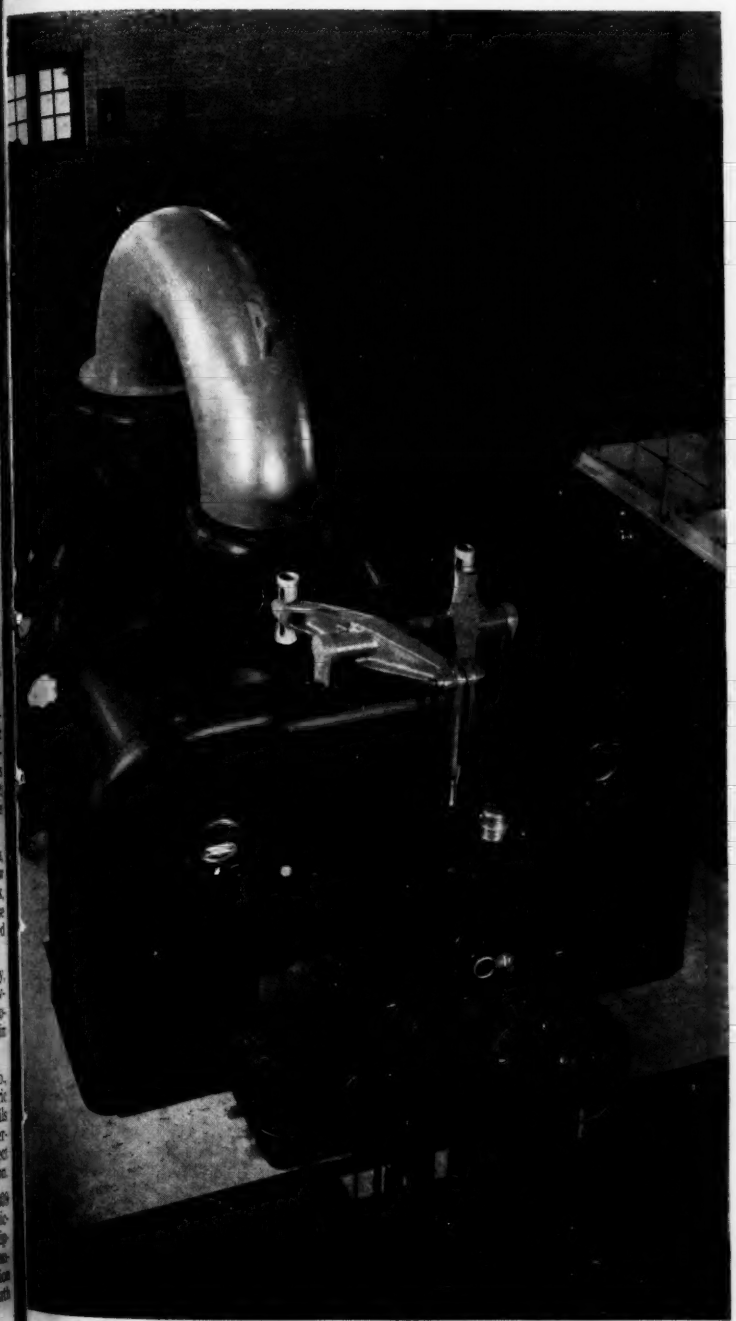
Power Plant ENGINEERING



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COVER: THIS 30,000 KW 1250 LB TOPPING TURBINE IS ARRANGED TO EXTRACT AS MUCH AS 50% OF ITS TOTAL STEAM INPUT

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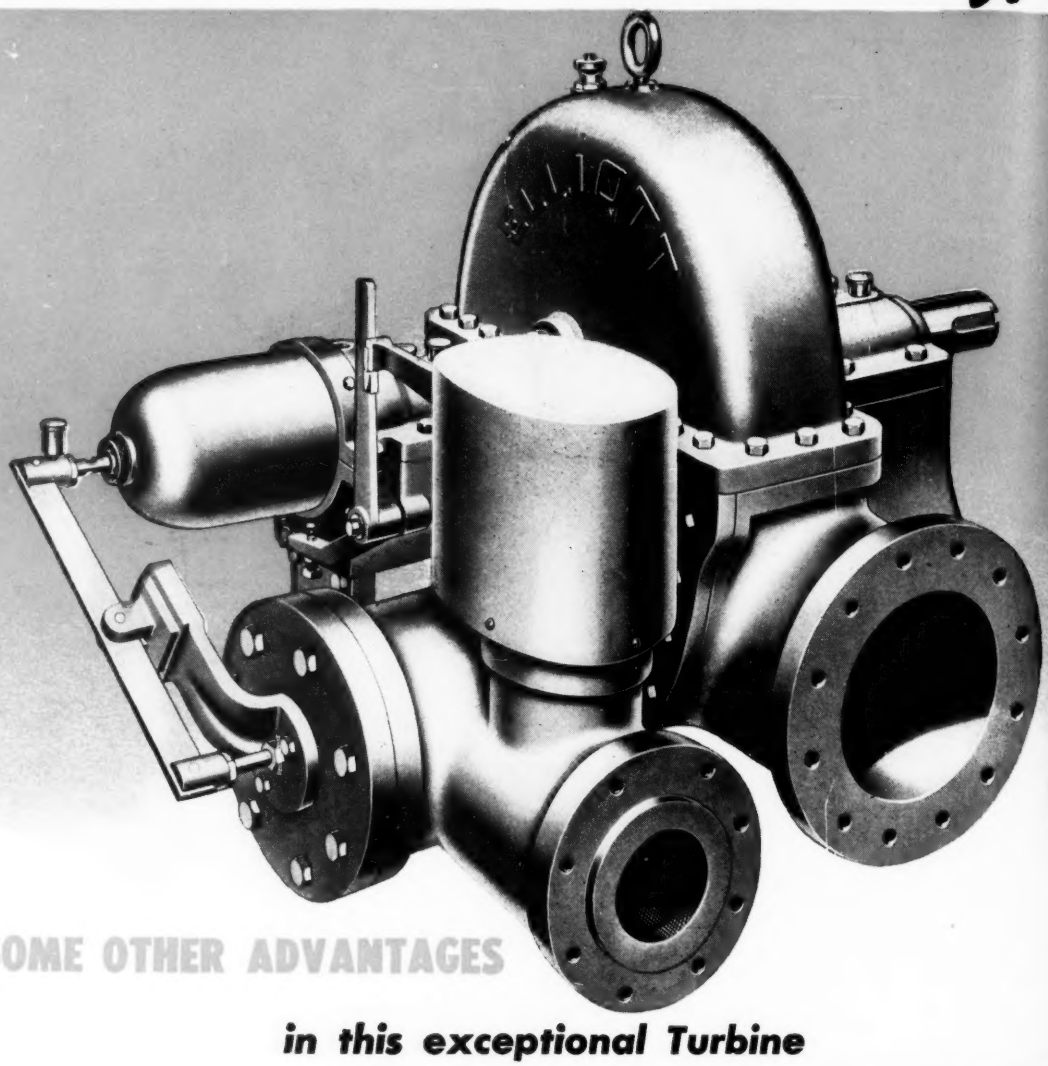
NOVEMBER, 1947

The new "YR" Turbine offers



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Power Plant ENGINEERING

November, 1947

VOLUME 51—NUMBER 11

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ENGINEERS' PREVIEW

HOUGH TOUGH!

The wind was rough
And cold and blough;
She kept her hand within her mough.

It chilled her through,
Her nose grew blough,
And still the squall the faster flough.

And yet, although
There was no snough,
The weather was a cruel fough.—London *Telegraph*

The correct pronunciation of "ough" in English words is hard on foreigners trying to learn the language. Martin Bretherton, in the London *Sunday Times,* says: "The version of the basic 'ough' which I have known for twenty years, and used, in sorrow, for purposes of illustration in teaching abroad, is:

A rough-coated, dough-faced ploughman strode through the streets of Scarborough, coughing and hiccoughing thoughtfully." Rightly enough, says *Gould Battery News* in reporting this, the editor who culled the above wrote: "Oughch!"

★ ★ ★

SOUND BUSINESS—industrial application of sound waves has received new stimulus with the erection by Ultrasonic Corp. of Cambridge, Mass., of a unit to precipitate carbon black for Godfrey L. Cabot, Inc. The agglomerates of carbon black issuing from the combustion chamber in the process are smaller than 10 microns (about as fine as face powder) and the sonic apparatus reportedly collects them as efficiently as a dry electrostatic precipitator—and with a cheaper installation. The method also appears promising in precipitation of acid mists and tars otherwise difficult to handle, according to the *Industrial Bulletin.* Experimental work with the method is also being done on natural fog. It has been used to accelerate the aging of whiskey and to improve operation of spray driers. Use of sound in formation of paper sheets by shaking water out may lead to similar uses in drying of textiles. Finally, the effect of sounds on human beings are being investigated by means of the new sonic equipment.

★ ★ ★

DEVELOPMENT of an automatic switcher for the Norfolk & Western Railroad is considered an important step forward in locomotive design. It was done to get a coal-burning locomotive that would have high availability, flexibility, reliability and low operating cost. An existing locomotive was equipped with an L. J. Wing induced draft fan, driven by a turbine using live steam; a Standard HT stoker, slightly modified; a complete Bailey automatic combustion control system; and a Worthington duplex steam pump controlled by a thermohydraulic regulator to maintain water level when the locomotive is left unattended.

INEXPENSIVE method for determining refrigeration compressor capacity by use of a split discharge system and thin plate orifice is described by A. D. Sullivan in the September, 1947, issue of the *Journal of the ASRE.* This system can be assembled of scrap material in 4 hours for less than $200. Compare this with the cost of an electric calorimeter designed for units of from 1/8 to 1 hp, which would cost over $1500 for design, materials and assembly. The apparatus can be designed for flexibility over a wide range of tonnage and the test time cut over the conventional method by 75 per cent. Reasonable accuracy is possible, operating costs of the method are low and the method should prove most useful for manufacturers in quickly determining the results of design changes, or for contractors and maintenance organizations in determining the efficiencies of compressors whose capacity has decreased due to wear in service or of rebuilt equipment. The article gives all necessary instructions for the test, curves of relations and detailed formulas for flow and the necessary calculations.

★ ★ ★

THE SLOW, onerous job of the oil and mineral prospector, riding with a week's kit on his trusty burro, is one more casualty of the war. In his place is the naval war veteran largely responsible for clearing the seas of Axis submarines—the magnetometer, or "aerial doodlebug"—a complicated device which looks like a 100-lb bomb suspended by special cable from an airplane. Scientists regard the magnetometer as a vital key to hidden natural resources and hope it will prove decisively that the United States has not, as some have said, lagged to a "have-not" rating in the raw materials of the earth. Suspended by its strong, intricate cable, this detector prepares a quick, large-scale and continuous survey of geological formations for the guidance of follow-up ground crews. Essential accessories are the unique electrical wires and cables manufactured by the electrical cable division of American Steel and Wire Co. Cables of this type range from 1/8 in. up to 7/8 in. in diameter and carry from one to six electrical conductors, depending on service required. The strength of the steel armor in all cases is sufficient to support more than 20,000 ft of cable with a reasonable factor of safety.

★ ★ ★

THOSE WHO have been wondering about the composition of the inks used in those ball point pens will find the answer, for certain pens at least, in U. S. Patent 2,416,145, granted to L. J. Biro. The ink, or more properly the writing paste, is described as a mixture of approximately equal parts of aniline dye and glycerine, and from 35 to 40 per cent of tacky dextrine obtained by mixing powdered dextrine with water and heating the mixture. The glycerine, according to the patent, acts as a lubricant for the ball and maintains the writing paste moist at the surface of the ball to effect good writing, and permits the use of the fountain pen for long periods from a single filling.

THROUGH THE USE of year-round air conditioning, made possible by the electric heat pump, the possibility of an increase in residential use of electricity in many households to an amount equal to over seven times the present average annual domestic consumption is implied in a report just published by the Indoor Climate Committee of the Edison Electric Institute's Commercial Division. Within the next few years, the report indicates, many American home owners may be using over 10,000 kwhr of electricity per year, as compared with the present average annual use of about 1,400 kwhr, assuming that suitable heat pump equipment is available and the several engineering problems still remaining are successfully solved. The heat pump is being actively developed by the electric utility industry, according to the report. Electric companies throughout the country are speeding test installations of heat pump systems, through cooperation with manufacturers and prospective users. The report discusses operating principles, with simplified diagrams used to show how the pump functions in both the heating and cooling cycles. A survey of heat pump installations in the United States made several months ago, showed a total of 46 residential systems, and 114 commercial installations in 18 states. A large majority employing air as the heat source. The Heat Pump Report is available from the Edison Electric Institute, 420 Lexington Avenue, New York 17, N. Y., at 25 cents per copy.

★ ★ ★

THEORETICALLY, all that is needed to convert wood into a true plastic material is some means to overcome the limitations of its shape and size as it grows in the tree. This has already been accomplished. The various processes that gave birth to the new family of lignocellulose plastics are, for wood, the equivalent of the operation by which we reduce metals to liquids and then cast or roll them into desired shapes. As distinguished from the plastics that emerge from wood pulp, wood sugar, and lignin hydrogenation, the lignocellulose plastics look like wood, retain all of the constituents of wood intact, and can perform wood's natural function as a structural material. Meeting an extraordinary variety of architectural specifications at low cost, lignocellulose plastics will become one of the pillars supporting the new Age of Wood, according to Egon Glesinger in *The Atlantic* for October.

These plastics are soon to move into the public domain. As a raw material, lignin might have to be produced at a rate of 100,000,000 tons a year. World consumption of cheap plastics could place these twentieth-century materials on a tonnage basis equal to that of metals, wood, stone, and other survivors of earlier ages. It should also be remembered that plastics represent only one of two self-contained cycles that can make full chemical use of all the wood in the tree. The second is liquid motor fuel, which could lay equally unlimited demand upon the world supply of lignin. Supplementing each other, the two could set the forest industries operating at full blast and would permit an elastic adjustment of wood chemistry and forest utilization to world economic conditions. Via both cycles, lignin, the last missing link, will connect up the conveyor chains and pipelines that lead from the forests to the fuel tanks, aircraft plants, and factories of tomorrow.

AN EARLY END for the high-powered aviation piston engine, both for military and commercial use, was recently forecast by Dr. John T. Rettaliata, head of the mechanical engineering department at Illinois Institute of Technology. In an address before the Mexico City section of the AIEE, he predicted that the gas turbine will be well entrenched within 5 years in the high-speed large commercial transport field, and within 10 years its supplanting of piston engines for this use should be essentially complete. "Already the gas turbine-jet propulsion combination (turbo-jet) has replaced the piston engine-propeller arrangement in the latest high speed subsonic military fighter planes," he said to an international audience. "The most recent bombers are also employing engines of the turbo-jet type. . . . Gas turbines driving propellers (turbo-prop units) through reduction gears are the best type of aircraft power plant for moderate subsonic speeds. . . . In supersonic speed ranges, three types of power plants for propulsion of aircraft are applicable: 1. Turbo-ram-jet engines; 2. ram-jet engines; 3. rocket engines. . . . "Notwithstanding some predictions to the contrary, he said, the personal plane will not be jet-propelled. Nor does it appear likely that gas turbines driving propellers will be used for personal planes in the foreseeable future. The small sizes make fuel consumption prohibitive.

★ ★ ★

MANY PEOPLE die either directly or indirectly of carbon monoxide poisoning each year. By the use of a secret gadget developed and manufactured during the war by the National Bureau of Standards, many lives can be saved. The N. B. S. Carbon Monoxide Indicator is used for "the rapid determination of infinitestimal" amounts of carbon monoxide in the air. The Indicator will detect and closely estimate less than 1 part of carbon monoxide per 500 million parts of air, which allows a big safety factor because it takes about one part of carbon monoxide in 10,000 parts of air to affect the human system. Field use requires only a small, inexpensive apparatus without maintenance problems, and involves procedures so simple that untrained personnel can obtain reliable results. The detector consists of a small glass tube sealed at both ends and a rubber bulb all packed into a small kit that fits into the pocket. When the presence of monoxide is suspected the kit can be opened, the tip broken off a small tube and one end inserted in the bulb to draw air samples through the chemicals in the tube. If carbon monoxide is present the yellow chemicals will turn green in thirty seconds. The darker the shade of green, the higher the monoxide concentration. A matching color chart tells how high the concentration is.

★ ★ ★

A RECENT report by the American Gas Association, "Literature Review of Corrosion of Metals and Materials by Flue Gas Condensate," contains a summary of the current literature and thought on the status of the causes and effects of corrosion of metals used in gas appliance construction by flue gas condensate. While this report refers particularly to heating appliances, it is believed the published information will apply to any situation where metal flues are used to carry off the products of combustion resulting from gas-fired appliances and gas-fired equipment.

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

STOKERS, OIL BURNERS

1 **Oil Burners**—Bulletin 65, 16 pages, covers this company's Type LAP, Model SC, Low Air Pressure Oil Burner. The bulletin describes each part of the burner in extreme detail and with excellent cross-sectional illustrations and photographs of the various parts of the unit. Burner sizes and capacities are listed in tabular form and line drawings illustrate such points as the interlocked air and oil proportioning operator, details and dimensions of the burner and typical installations of the unit. Tables of air volume, dimensions and weights, blower correction factors, and various rating bases, tables of piping and air flow data, heat content of fuel oil, and other useful data are presented in tabular form. National Airoil Burner Co.

2 **Stokers** — This company's underfeed stokers are described in this 12-page bulletin SB 27-5M. Line drawings and tables give the dimensions of the various types of stokers. Excellent photographs picture the different parts of the equipment and show the stoker on the test floor, the control panel, and the stoker firing different types of boilers. Line drawings also illustrate the stop-start control and the automatic control. Erie City Iron Works.

3 **Worm-Feed Stokers**—Bulletin S-70 (Second Edition), 8 pages, describes the company's type C, worm-feed stokers. Shown in the front of the booklet are cutaway views of the transmission and also photographs of the rear view of the side dump grates and of the automatic air volume control. The center spread of the bulletin has a large exterior photograph of the stoker on which are shown numbered colored arrows; the text describes the various features pointed out by these arrows. Detailed features of the unit such as the gas repellent valve are described in the remainder of the bulletin. The Brownell Co.

4 **Burners**—Bulletins 803 and 903, 4 pages, describe respectively, the operation of heavy-duty mechanical and steam-atomizing oil burners and combined gas and oil burners for industrial boilers, heaters and furnaces, as well as central station installation. Automatic fuel oil pumps and heater sets are also described. Peabody Engineering Corp.

5 **Stokers**—Bulletin No. S-31 (10th Edition), 8 pages, describes this company's Types R and RI Ram-Feed Stokers. The advantages and outstanding features of these stokers are given and the illustrations are unusually good. One large cross-sectional diagram shows how the Type RI stoker is installed in a boiler. The Brownell Co.

INSTRUMENTS, CONTROLS

6 **Recording Thermometers** — Bulletin T835, published recently, is a 16-page bulletin describing this company's recently announced line of Series 500 recording thermometers and gages. The new bulletin gives detailed information in the form of descriptions and pictures of the new instruments. Other features of the bulletin are the sections giving complete information on chart ranges, chart drives, thermometer bulbs and measuring elements. The Bristol Co.

7 **Control Actuator**—This company's new snap acting "wizard" pilot is described in Bulletin D-2. The pilot is for use in on-and-off pilot operated pressure control service. The bulletin points out some of the uses of the device in oil well work and on gas lines. General applications are also covered. The remainder of the booklet covers the construction, operation, and snapping range of the unit. List prices are given. Fisher Governor Co.

8 **Electronic Controls** — Bulletins 588 and N-789 describe this company's line of electronic instruments and controls for industry. Among the controls are: a smoke detector, flame gage, operation recorder, indicator recorder, potentiometer and several types of flame failure alarms. Specifications of the instruments are given and tables show accessories available with some of the units. The bulletins are well illustrated and one full page drawing shows an installation wiring diagram for the flame failure detectors. Ess Instrument Co.

9 **Boiler Feedwater Control** — Bulletin 453, titled, "Controlling Boiler Feed Water for the New Generating Station at the New York Naval Shipyard" has just been issued. It is written by William H. Welsh, Master Mechanic. The bulletin is well illustrated showing various views of the station and most particularly the feedwater control devices. Table of significant data is given and charts of boiler load and feedwater are included. Northern Equipment Co.

10 **Electronic Combustion Control**—Bulletin SA-2-47 describes this company's Robot-Eye, the electronic combustion control which has been designed for industrial plants, hotels, office buildings and large apartments. Advantages of the unit, what it does and how it does it are described in the front part of the bulletin. Its application to rotary cup burners is described in detail. The complete equipment is described and the component parts which make up the system also are described and illustrated. Methods of installation are shown by means of line diagrams and charts show linkage movement and oil consumption. Typical applications of the control to heating boilers are presented on the last page. General Power Plant Corp.

11 **Controllers** — Catalog No. 8905, Air Operated Controllers, 40 pages, contains valuable information on instruments for the automatic control of industrial processes. Incorporated in this catalog are descriptions of control instruments for temperature, pressure, flow, liquid level and humidity. Photographs, schematic drawings and diagrams illustrate the construction and principles of operation of all instruments described, including control accessories, Air-o-Line Controller, Throttlers, Valve positioner, Integral Control By-Pass, etc. The Brown Instrument Co.

12 **Differential Controllers**—Catalog 2221, 48 pages, describes this company's differential controllers for flow and liquid level. The bulletin starts out by describing typical applications of this differential controller in industrial processes. A cross-sectional view of the mechanical meter body is shown and construction features are pointed out. The advantages of the construction of various detailed parts of the unit are shown in the following pages. Similar treatment is accorded other units in the line. Principle of operation of the Air-o-Line controller is given considerable space and pneumatic remote transmission also is covered. Tables of availability with various key numbers are given. Flow and liquid level charts are listed in tabular form for ease in ordering. The Brown Instrument Co.

TREATMENTS

13 **Boiler Water Treatment**—This 8-page booklet describes the company's organic colloidal materials that have special application to industrial water problems. The description points out how the products are formulated and chemically corrected and continues with a description of the adjunctive treatment for zeolite and lime-softened boiler water. Union Chemical & Oil Co.

14 **Zeolite Softeners**—Publication 4345 is a new 20 page manual describing this company's greensand zeolite softening process. Applications of the process to boiler feed, water jacketed equipment and processing in specific industries such as food canning, laundries and institutions are briefly described. The chemistry of the process is covered briefly and cutaway views of the equipment aid in the understanding of its operation. The use of multiple units is explained where the softening process cannot be interrupted for periodic regeneration. Cochrane Corp.

15 **Soot Remover**—This product called "Sootoxin" is described in a recently issued 6 page folder. The bulletin tells how the chemical eliminates soot from furnaces, boilers and chimneys by combustion. Diagrams show how soot collects on the boiler walls and around steam tubes, thus reducing the heat transfer. Continental Asbestos & Refining Corp.

16 **Resins**—"The Role of the Amberlites (Ion Exchange Resins) In Water Treatment, In Chemical Processes" is the title of a new booklet which deals with contributions made by the Amberlites in the transportation, chemical, canning, bottling, textile, dye and pigment industries. Various processes are described which include deionization of locomotive water, control of alkalinity, prevention of scale in heat transfer processes, etc. Resinous Products & Chemical Co.

17 **Water Conditioning**—Bulletin 6 and 7 discuss, respectively iron and manganese removal and silica removal in water conditioning service. Both bulletins describe the most modern processes and types of equipment and are illustrated with diagrammatic drawings showing principles of design. Liquid Conditioning Corp.

MECHANICAL TRANSMISSION

18 **Gear Reducers**—Book N. 1819, 68-pages, describes many new sizes and types of enclosed herringbone gear units for speed reducing and speed increasing service. These reducers are said to be efficient, compact, smooth-running and are designed for heavy-duty industrial service. The book includes reducer selection data and examples of proper application, dimensions and horsepower ratings, lubrication data and tables of maximum allowable pull on high and low speed shafts. Photographs of a great variety of installations are also given. Link-Belt Company.

19 **Speed-Jack Drives** — This company points out that the users of variable speed transmissions can now quickly get desired maximum and minimum speeds on machinery drives operating up to 1 hp by referring to this new bulletin. The bulletin features easy-to-use drive tables and charts that enable users to select quickly the proper size sheaves for the

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NOVEMBER, 1947

POWER PLANT ENGINEERING

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desired range of speed. In addition, the bulletin shows construction details and suggested applications for the drives. Other pages show the unique features of universal mounting in any position in or on the machine and the remote control of machine speed through the flexible shaft. The American Pulley Co.

20 **Adjustable Speed Drive** — Bulletin No. 611 C, 4 pages, describes an alternating current motor having infinitely adjustable speed. A fairly detailed description of the adjustable speed drive construction and operation is described in the inside of this folder. Accompanying the description is an exceptionally fine combination wiring diagram and sectional view of the adjustable speed drive. On the last page of the folder there are presented two charts; one which shows the relation between the output shaft speed in rpm to the per cent power factor, the second shows the relationship between the load and the speed in percentages. The Louis Allis Co.

LUBRICATION

21 **Oil Filters** — Bulletin 7B, 4 pages, describes this company's oil filters for fuel and lubricating oil of internal combustion engines. Bag and absorbent type filters are discussed and illustrations show all the details of the filters as well as various cartridges. Two line drawings show the oil piping arrangement to the filters. A microscopic photo shows a "before" and "after" view of an oil sample. Wm. W. Nugent & Co., Inc.

22 **Bottle Oilers**—Circular 560-RL tells what bottle oilers are and how and where to use them. Five methods of application are given with cross-sectional views illustrating each one. Some typical installations are shown on fan shaft bearings, loom bearings and roller shaft bearings. A table of price lists and leading dimensions is given in the back of the folder. The Lunkenheimer Co.

ELECTRICAL

23 **Power Transformers**—Manufacturing facilities of this company's power transformer division are shown in this recently issued bulletin, Form TU-16B. Views throughout the shop are presented and pictures showing workmen winding a helical coil on a Bakelite cylinder and also operation of electric ovens are among the photographs presented. Other pictures show vacuum tanks and transformer testing. Wagner Electric Corp.

24 **Wires and Cables**—Bulletin OW-1031A is an 8-page bulletin which presents a selection chart for wires and cables of all types from aerial and aircraft to buildings, ignition, neon signs and portable. The various types of cables are illuustrated with cutaway sectional views which show the types of construction. The bulletin further covers types of insulation and construction and coverings. The Okonite Co.

MAINTENANCE

25 **Asphalt Paint**—This 4-fold folder describes the use of this asphalt paint wherever chemical fumes, moisture, smoke and gas, or heat and cold may tend to shorten the life of paints not specifically designed for application in these places. Color samples of the paint are given and a brief description of the paint giving the reasons why it has resistance to corrosive action is given on one page. American-Marietta Co.

26 **Protective Coatings** — This 4-page bulletin describes a substance made from a special combination of synthetic resins and inert pigments which may be applied by brush or spray gun. The bulletin points out that the material is unaffected by salts, insoluble in alcohol, impervious to fats, oils and waxes, is fire retardant and has many other qualities which render it highly desirable as protection against all types of corrosion. Photographs show places where material has been applied and the back page of the bulletin gives complete application directions. Prufcoat Laboratories, Inc.

27 **Building Maintenance**—Fifteen building maintenance problems are illustrated and discussed in this 3-color folder. Included in this guide are the company's solutions to such problems as leaky roofs, worn flashings and gutters, rough concrete and wood floors, etc. This folder is unusually well illustrated with key numbers and arrows pointing out the various maintenance problems. Stonhard Co.

28 **Protective Coating**—This 4-page pamphlet describes "Liquinoleum" which is said to protect, waterproof, preserve. A list of its advantages are given and photographs show typical applications. A series of illustrations show the effect of the elements on surfaces not using this coating, and five different methods are given for testing the product. Continental Asbestos & Refining Corp.

VALVES, PIPING

29 **Coils Data Book**—This engineering data book, 34 pages, provides the fundamentals of pipe and fin coil calculation. The book has been compiled for draftsmen and designers to provide information necessary for laying out pipe and fin coils for heating and cooling applications. It treats heat transfer "K" factors for all ranges of heating and cooling from minus 6 to plus 350 F and shows how to calculate and design coils for all generally encountered heating and cooling loads. The book also treats inspecting, testing and finishing of coils and many other subjects. The book is well illustrated and has many pages of tables. The book sells for $1.50 and all orders should be directed to The Rempe Co., 340 N. Sacramento Blvd., Chicago 12, Ill.

30 **Valve Bodies**—Bulletin R-1, 4 pages, describes this company's high pressure cast steel D bodies. The bulletin points out the various features of the bodies and a table on high pressure valve body description gives all the information on the different types. Illustrations of application for high pressure gas and oil field service are given, also line drawings and charts showing the body dimensions in inches. Fisher Governor Co.

31 **Valve Control**—Showing how gate valves are operated by the company's electric valve control is the purpose of this recently-issued 12 page bulletin. The description points out features of the control such as the elimination of a constant exhaust, the availability of fast or slow operation, simplified design, the control of water hammer and automatic safety shut off. Shafer Valve Co., Inc.

32 **Safety Heads**—This 4-page pamphlet describes this company's safety heads, combination safety head and relief valves, horizontal chemical feeders and pressure-vacuum vent valve. Three types of safety heads are illustrated and tables giving the ratings and sizes in which each are available are given. Specifications and cross-sectional views of the other equipment give a complete picture. Black, Sivalls & Bryson, Inc.

33 **Valves**—Bulletin E-9, 4 pages, describes interchangeable inner valves to obtain reduced size trim for control valves and gives the advantages. Cross-sectional views show the various features of the valves and a table gives the valve sizes available. A chart shows the comparison of capacity and characteristics of the inner valve. Fisher Governor Co.

METALS

34 **Corrosion-Resistant Alloys** — Titled, "Guide to Selection of Durco Corrosion Resisting Alloys," this Bulletin 100 lists 155 corrosives in alphabetical order and shows which of the five alloys produced by the company offers the most satisfactory resistance to each corrosive. Where two or more alloys are satisfactory for a particular service the bulletin enables the user to make a selection on the basis of the most economical alloys possessing the required mechanical properties. A table is provided which shows these mechanical properties. The Duriron Co., Inc.

35 **Nickel Alloy Welding**—This new 16 page booklet is concerned with the materials required for metal arc, oxy-acetylene and submerged melt welding of nickel and the high nickel alloys. Also, it lists such general information as the type of welding rods to use, recommended amperages for electric-arc welding, and the proper flux to select for gas welding and brazing. Information also is included on technical booklets on the subject of welding. The International Nickel Co.

36 **Nickel Cast Irons** — The engineering properties and application of "Ni-Resist," this company's nickel alloyed cast iron, is described in a revised 36-page bulletin. The booklet gives detailed information on the physical and mechanical properties of this cast nickel alloy. Performance under a wide variety of industrial conditions involving corrosion, heat and wear is described. Corrosion data for 400 corrosive media are presented in tabular form. The booklet is completely indexed. The International Nickel Co., Inc.

PUMPS, COMPRESSORS

37 **Industrial Pumps** — Bulletin 547-IP, 8 pages, describes Type T industrial pumps. The booklet is made up in picture magazine style featuring a minimum of copy and a maximum of photographs. In order to show the design and construction of these material handling pumps, one series of photographs shows the complete start-to-finish assembly of a typical pump. Other pictures and diagrams show how the material of which the pump is made assure maximum resistance to impact, shock and abrasion. American Manganese Steel Div.

38 **Air Compressors**—Bulletin E-219, describes a new line of industrial air compressors. It contains mechanical data and specifications on complete units from 60 to 315 cfm capacities. It also lists bare compressors suitable for installation with customers' motors or as replacement machines. Advantages of the "departmental" or "at-the-job" compressor system are described in the catalog. Davey Compressor Co.

39 **Centrifugal Pumps**—Bulletin 4013-A describes this company's single stage, side suction, centrifugal pumps. A sectional view of the unit and exterior views are used as illustrative material and various parts of the unit also are shown in halftone illustrations. Types of construction and tables of performance for motor driven and belt driven units are given. One full page of dimensional tables also shows dimension drawings. Another product described is sump pumps. Engineering information includes tables of comparison of pressures and other conversion factors, suction lift of pumps, suction head requirements when pumping hot water and tables of pipe friction. The Deming Co.

40 **Aftercoolers**—The benefits, principle and application of aftercooling and a complete description of a line of Type PL and M aftercoolers are fully covered in this new 16-page, Form 3014-B. Several pages illustrate the various aftercoolers with cross-sectional view and description of their operation. One spread is devoted to a typical compressor plant set-up, showing a complete layout including compressors, intake filter, piping, receivers, headers and control panel. A selection table for choosing the proper size aftercooler for specific compressor output is also included in this bulletin. Ingersoll-Rand Co.

41 **Condensate Return** — Bulletin CR-1, 24 pages, describes a complete line of condensation return units and boiler feed pumps. Instructions on the proper use of a unit are given and several full-page master selection tables are printed. The booklet shows illustrations of each of the units and also gives complete size, capacity and dimensional information. A complete line of accessories is described in the back part of the booklet. Engineering information includes drawings of typical installations and tables showing pipe friction of various sizes of pipes, contents of round tanks, etc. The Deming Co.

INSULATION

42 **Low Temperature Insulation** — Described as a manual for businessmen concerned with cold storage, freezing, cooling, air conditioning, refrigeration and food distribution, this 20 page manual also contains many points of interest to the engineer. Typical examples of improvements made in plant refrigeration are narrated and line diagrams, tables and photographs show the resulting advantages. Drawings show different techniques for insulating the walls of coal storage spaces, charts aid in the computation of minimum insulation thickness in order to prevent condensation. Industrial Mineral Wool Institute.

43 **Insulation**—Volume 17, No. 2, of "Insulator," 14 pages, describes the three basic problems in block frozen foods and illustrations show the newest equipment. Cork covering is discussed and a step-by-step picture story of the manufacturing process is given. Line drawings show typical insulated rooms from 55 to 130 F and a series of line drawings gives a clear picture of suspended ceilings of various types and describes their construction. Armstrong Cork Co.

MISCELLANEOUS

44 **Safety Tool Catalog**—Catalog 118, 32 pages, describes this company's line of non-sparking, non-magnetic, non-corrosive metal safety tools. The various tools are illustrated and listed alphabetically in

(Continued on page 170)

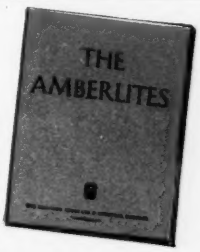
Amberlite-treated cooling water prevents scale formation in heat exchangers

In the giant refining industry, scale-forming ions are being removed from the cooling water for heat exchangers . . . to prevent the formation of efficiency-reducing deposits. The AMBERLITE Ion Exchange Resins do the job!

In *many* a major industry, the AMBERLITES are being successfully used to soften cooling and boiler feed waters; to reduce alkalinity and total dissolved solids; to regulate make-up quality; or to produce *completely* deionized water comparable in purity to single distilled. All with a minimum of equipment, space and maintenance!

In chemical processes, too, costly steps can often be eliminated...product quality improved...with the aid of the AMBERLITES. Our technical staff will be glad to discuss potential applications.

Time-Tested Uses and New Ideas Worth Investigating



*Our booklet "*THE AMBERLITES*" suggests many applications for these time-tested Ion Exchange Resins—some applications already commercially established, others pointing the way to new fields of investigations. For your copy of this booklet, address The Resinous Products & Chemical Company, Department CE-8, Washington Square, Philadelphia 5, Pa.*

AMBERLITE *is a trade-mark, Reg. U. S. Pat. Off.*

THE RESINOUS PRODUCTS & CHEMICAL COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Meeting your steam requirements with CONTROLLED SUPERHEAT over WIDE LOAD RANGES

A METHOD of superheat control which successfully overcomes the disadvantages of methods such as damper by-pass, "desuperheating" by spraying water into steam, and others, has been developed and applied to Foster Wheeler steam generators.

The Foster Wheeler method operates by reducing the latent heat of the steam in the superheater inlet header. It differs from conventional desuperheating because no water is added to superheated steam. Simply, superheating becomes a controlled operation from inlet to outlet.

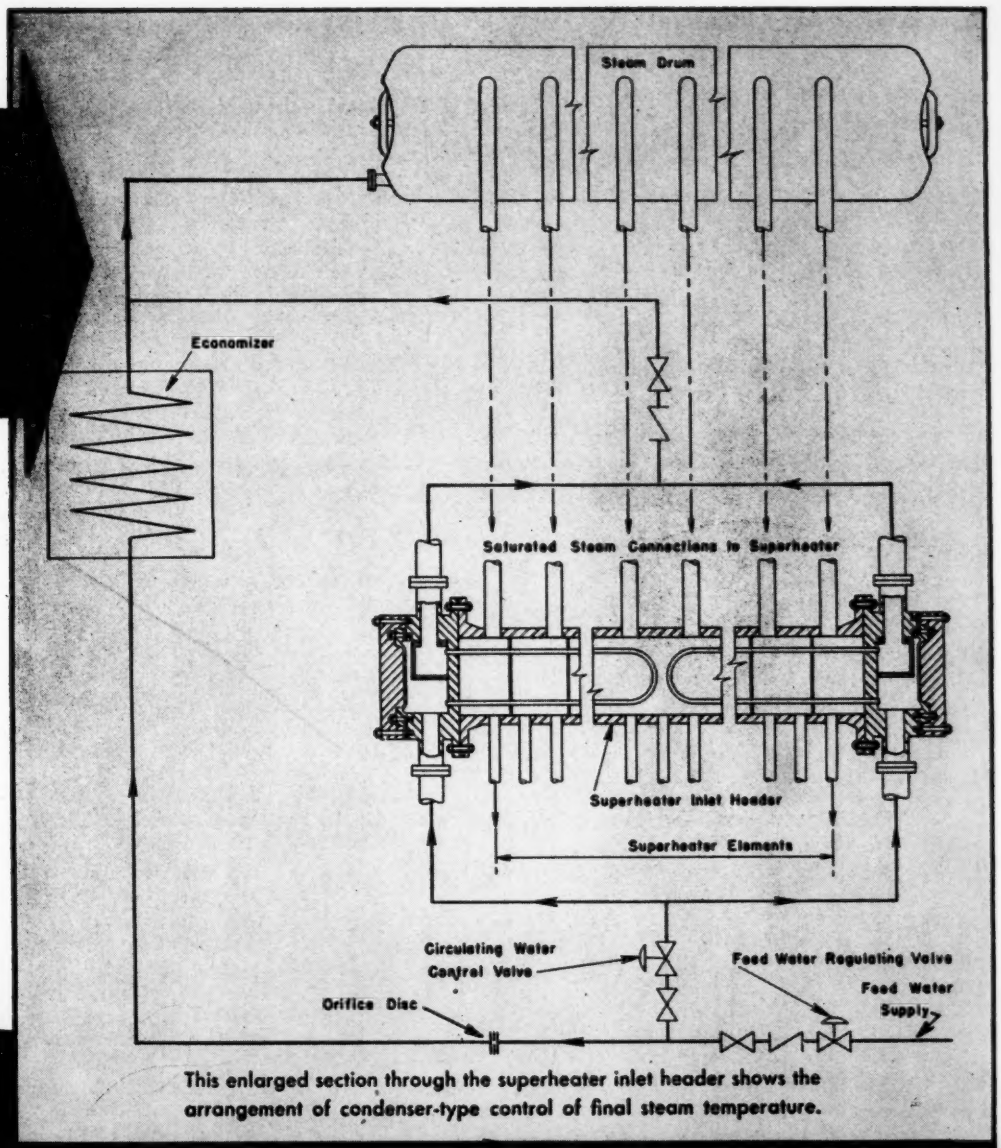
Boiler feedwater is diverted around the economizer and passed through tube bundles located in the superheater inlet header. This relatively cool feedwater condenses some of the entering cleaned and dried steam. The amount of moisture entering the superheater is regulated to provide positive and accurate control of final temperature. In addition to the wide range control possible when this device is used, superheated steam is not contaminated by water, and excessive metal stresses are avoided.

A reprint of an article describing in detail a specific application of Foster Wheeler condenser-type superheat control is available. Ask for B-46-20.

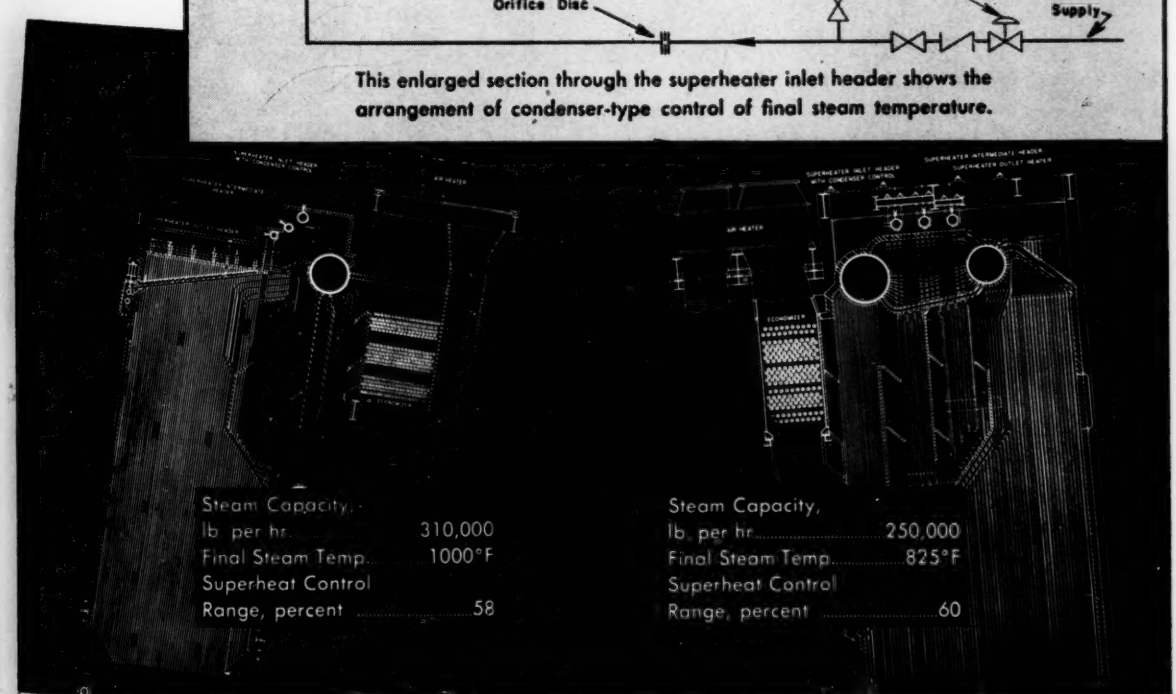
FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK

Steam Capacity, lb. per hr. 640,000
Final Steam Temp. 900°F
Superheat Control Range, percent 62
Steam Capacity, lb. per hr. 375,000
Final Steam Temp. 900°F
Superheat Control Range, percent 47
Steam Capacity, lb. per hr. 325,00
Final Steam Temp. 900
Superheat Control Range, percent



This enlarged section through the superheater inlet header shows the arrangement of condenser-type control of final steam temperature.



Steam Capacity, lb. per hr.	310,000
Final Steam Temp.	1000°F
Superheat Control Range, percent	58

Steam Capacity, lb. per hr.	250,000
Final Steam Temp.	825°F
Superheat Control Range, percent	60

There's an Inco Nickel Alloy to solve every one of these problems

You're probably meeting these problems every day. They cause shut-downs, expensive repairs, and extra labor.

To beat them, engineers choose metals that can really "take it" . . . INCO Nickel Alloys.

These metals help fight the erosion of blasting steam and solid particles. They never rust. They resist corrosion caused by all natural elements and most chemicals. They help solve problems involving high temperatures, impact, and over-stressing.

In valves, INCO Nickel Alloys prevent binding and galling. Nuts and screws made of these alloys stay tight . . . but never freeze. Gaskets keep joints tight for years longer . . . cut replacement costs 'way down.

In fact, wherever you use INCO Nickel Alloys you always build in extra performance.

Make ALLIES of these ALLOYS

MONEL* — Rustproof, corrosion-resisting alloy for general applications that require a tough, high-strength material.

"R"* MONEL — Free-machining nickel-copper alloy for automatic machining and intricate machined shapes.

"K"* MONEL — Can be heat-treated after finishing — for applications that require a corrosion-resisting material with extremely high strength and hardness. Non-magnetic.

"KR"* MONEL — Machining-quality material which can be heat-treated to develop high mechanical properties similar to those of "K" Monel. Non-magnetic.

"S"* MONEL — Extremely hard and strong cast alloy for valve trim, pump liners, and similar applications. Non-galling. Retains high hardness at red heat.

INCONEL* — Heat-resisting nickel-chromium alloy to endure temperatures up to 2000°F. High hot-strength and resistance to progressive oxidation and inter-crystalline attack. Non-magnetic.

NICKEL — Commercially pure nickel for radio tube parts and electrical uses, gaskets, high temperature applications and corrosion-resisting service.

"D"* NICKEL — For spark plug electrodes, gas engine ignition tubes, thermometer wells and other high temperature applications not requiring a material with mechanical properties quite so high as those of Inconel.

"L"* NICKEL — Low-carbon nickel for special high temperature service (800-1100°F.), and for resistance to the corrosive effects of certain chemicals.

"Z"* NICKEL — Spring-quality material. Can be heat-treated after forming to develop from 200,000 to 240,000 psi.

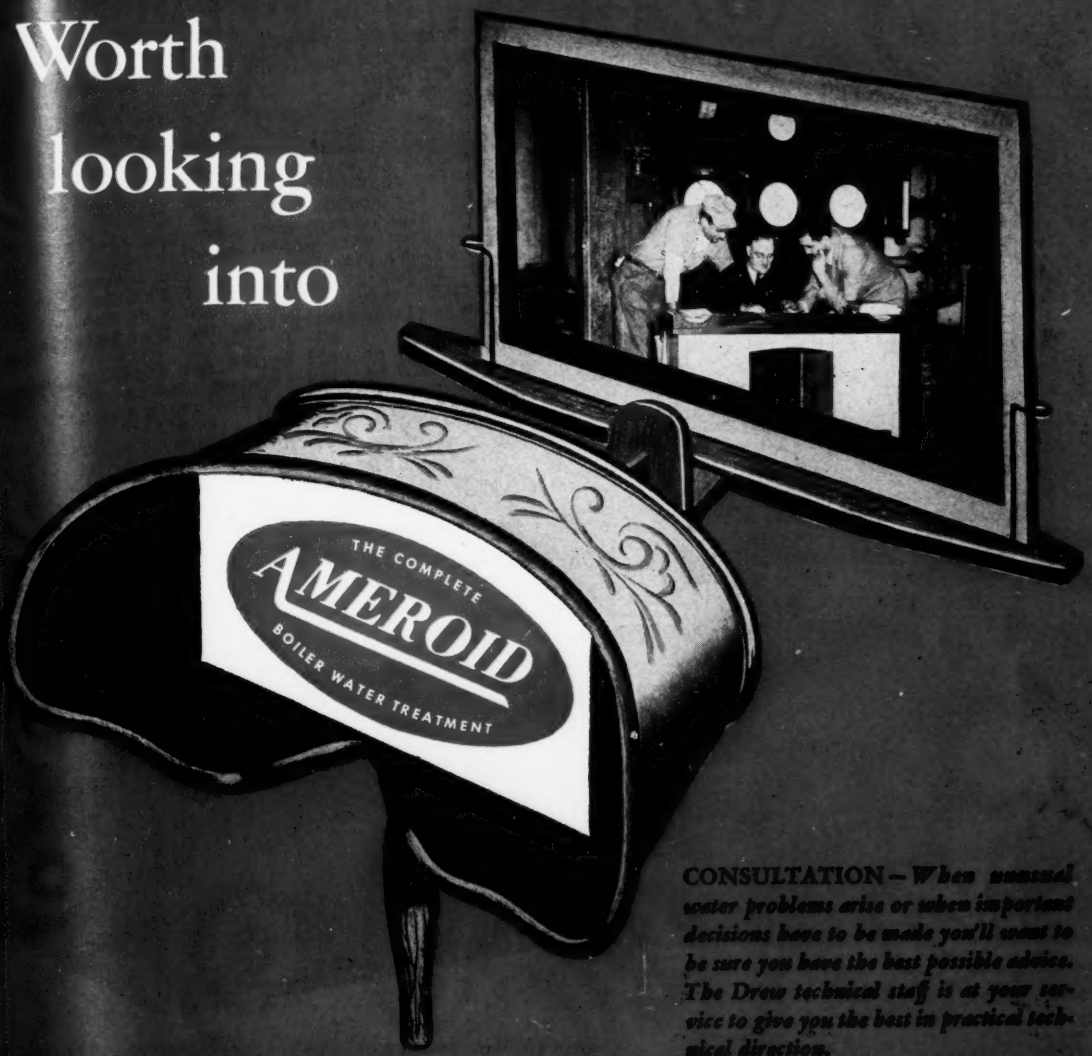
• • •

Detailed literature concerning the behavior and engineering properties of any of the above Inco Nickel Alloys will be mailed on request.

*Reg. U. S. Pat. Off.

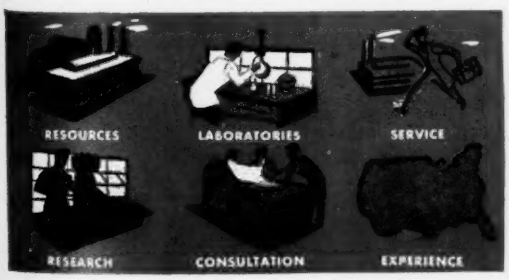
THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK 5, N. Y.

Worth looking into



CONSULTATION—*When unusual water problems arise or when important decisions have to be made you'll want to be sure you have the best possible advice. The Drew technical staff is at your service to give you the best in practical technical direction.*

When you look into the AMEROID system you'll find it backed by all the factors necessary for a completely successful boiler water treatment . . . a national service organization of trained chemists and engineers; modern analytical laboratories; controlled manufacturing facilities; a progressive research program; and the "know how" that comes only from wide experience. An AMEROID representative will be happy to discuss boiler water conditioning with you at your convenience.



E. F. DREW & CO., INC.
15 EAST 26th STREET, NEW YORK 10, N. Y.
COMPLETE AMEROID SERVICE is available in key cities of the United States, Canada, Mexico, Brazil and Puerto Rico.

"HAS OPERATED 99% OF THE TIME SINCE 1939"

reports the City of St. Mary's, Ohio, of their first 2500 KW Worthington Turbine Generator.

New 2500 KW Worthington Turbine Generator recently installed in municipal power plant of the City of St. Mary's, Ohio.

Mr. George Probst
Worthington Pump and Machinery Corporation
Steam Turbine Division
Wellsville, New York

Dear Mr. Probst:

You will be interested, I'm sure, to learn that our new 2500 KW Worthington Turbine Generator has been running continuously since it was put on the line about six months ago.

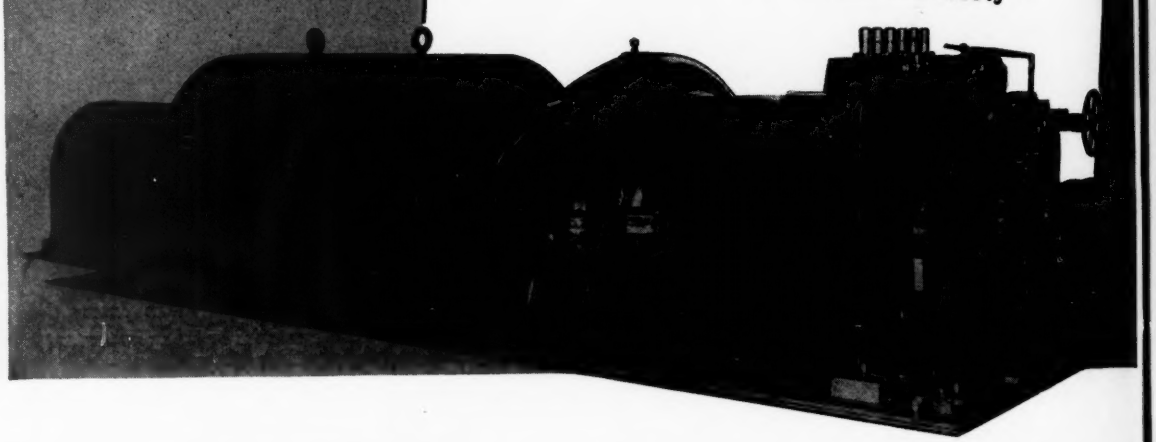
It's been eight years now since our original 2500 KW Worthington unit was started and it has operated 99% of the time ever since. On a number of occasions, it has carried loads of 3000 to 3500 KW for periods of three to four hours. We run both units a large portion of the time and they parallel very nicely.

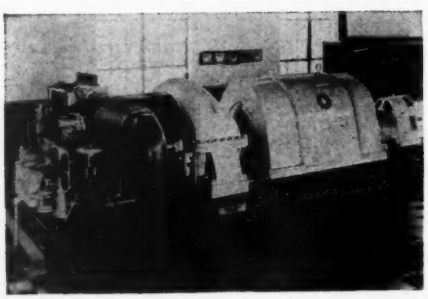
In fact, we do so well with these Worthington units that we would be glad to show them in operation to any of your prospective customers who care to visit our plant.

Very truly yours,
CITY OF ST. MARY'S

J M Hageman

City Engineer and Director
of Service and Safety

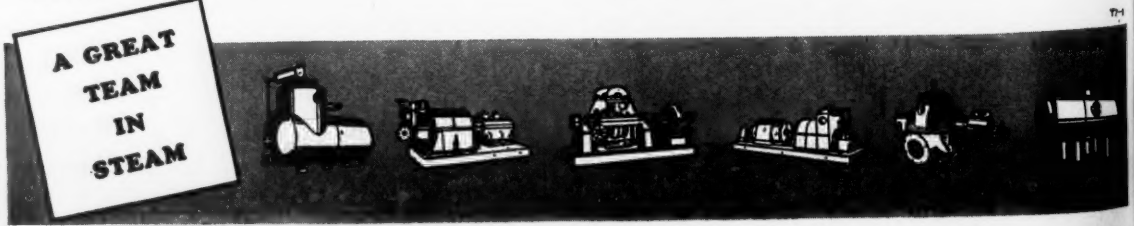




2500 KW Worthington unit installed in 1939. Turbine, straight, condensing type, operates on 400 lbs. steam pressure, 750 degrees total temperature and exhausts into a vacuum of 28"

Many similar reports from power users throughout the country testify to the trouble-free, cost-saving performance of Worthington steam turbine equipment. In your own turbine problems, Worthington specialists are always available for expert technical advice. And for further proof that *there's more worth in Worthington*, write for fact-full literature. *Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, N. Y.*

WORTHINGTON



STANDARD ENGINEERS NOTEBOOK

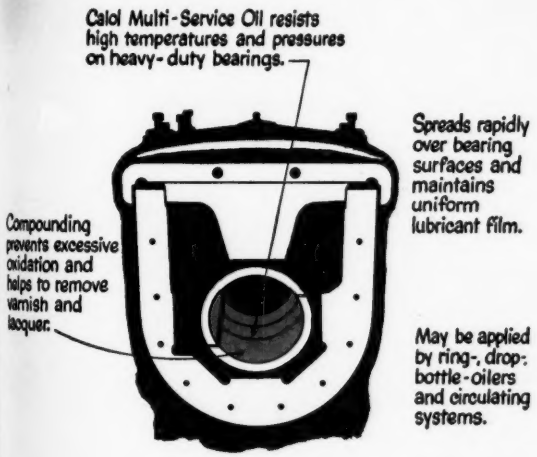
CALOL RPM

Multi-Service Oil efficient in tough service

Because it is made of high-quality stable oils and contains detergent and oxidation-resistant compounds, Calol Multi-Service Oil has decreased the amount of oil used in air compressors as much as 20% in some cases. It is also highly efficient in the lubrication of natural gas engines, industrial Diesel engines, vacuum and pressure pumps and enclosed reduction gears and their integral parts.

Calol Multi-Service Oil spreads rapidly on bearing surfaces, adheres tightly and withstands high temperatures and pressures. It comes in six viscosity grades: 45X, 50X, 55X (SAE 20), 65X (SAE 30), 75X (SAE 40) and 85X (SAE 50).

Where rapid separation from water is not required, Calol Multi-Service Oil may be applied satisfactorily by oil circulating systems. It is also applied by ring-, drop-, bottle-oilers and by hand oiling.


Calol Multi-Service Oil resists high temperatures and pressures on heavy-duty bearings.
Spreads rapidly over bearing surfaces and maintains uniform lubricant film.
Compounding prevents excessive oxidation and helps to remove varnish and lacquer.
May be applied by ring-, drop-, bottle-oilers and circulating systems.

Air Compressor Main Bearing.

This drawing prepared with cooperation of Chicago Pneumatic Tool Co.

Calol Pinion Grease is black, adhesive – flows slowly back after displacement by pressure.
Light grade is recommended for enclosed spur, and herringbone gears.
Comes in four high-viscosity grades.
Cushions shocks and reduces frictional losses caused by sliding action.

Section of Pinion and Girth Gears on Rotary Drier.

Calol Pinion Grease sticks on open gears

Because Calol Pinion Grease is extremely adhesive and flows back into place when displaced, it will not drip off and waste away from large open gears.

The tenacious lubricant film provided by this oil-like grease withstands high pressures and acts as a cushion under shock loads. It reduces to the minimum frictional losses caused by the sliding action of gear teeth and resists high temperatures.

The lightest grade, Calol Pinion Grease 0, is particularly adaptable to open gears operating at high speeds. It is also recommended for grease-lubricated enclosed gears where climatic temperatures are low.

Calol Pinion Grease is also used on wire rope. In this use, the application should be as light as possible.

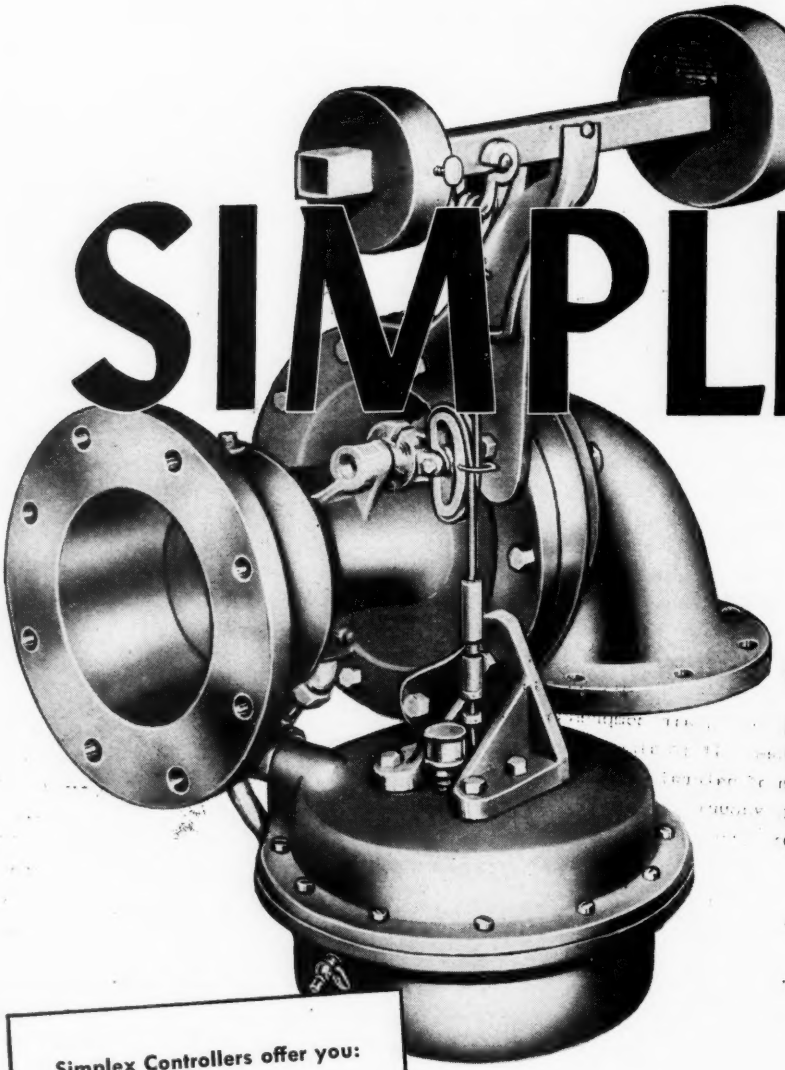
It comes in four grades: 0, 1, 2 and 5. The heavier grades are increasingly more adhesive. In some cases they require heating for correct application.

Trademarks, "Calol," "RPM," Reg. U. S. Pat. Off.

For additional information and the name of your nearest Distributor, write Standard of California, 225 Bush Street, San Francisco 20, Calif.; The California Oil Company, 30 Rockefeller Plaza, New York 20, N. Y.; The California Company, 17th and Stout Streets, Denver 1, Colo.; Standard Oil Company of Texas, El Paso, Texas.

FOR EVERY NEED A **STANDARD OF CALIFORNIA** JOB-PROVED PRODUCT

SIMPLEX



TYPE "S" CONTROLLERS—

Simplex Type "S" Rate of Flow Controllers are of the most advanced, proved design! They meet every requirement of modern filter plants!

Simplex Controllers offer you:

- compact design, low weight
- short length, low height, narrow width
- ball bearing mounted shaft
- hydrostatically balanced, patented guillotine valves
- simple, direct action design
- venturi tube type of differential pressure producer
- quick starting from open position
- instant response to slightest differential pressure
- extreme accuracy of control over long range

SIMPLEX TYPE "S" CONTROLLERS ARE USED extensively in controlling the rate of flow in filter effluent lines, as well as maintaining water levels on filter beds or in clear wells. They will maintain balance between input and output through filter plants. In addition they are used for controlling wash water.

Simplex Gauges for use with these controllers indicate and record the rate of flow or loss of head of water through the filters, or will measure water during washing cycles.

SIMPLEX VALVE & METER COMPANY

6783 UPLAND STREET, PHILADELPHIA 42, PA.

A coal supply that is wet, dry, or partially frozen will no longer be a problem with an Æ Perfect Spread Stoker in your boiler room. You will be able to feed it a wide variety of fuels and watch it operate quietly and efficiently—without clogging. Whether you're now hand-firing your boilers or want to replace inefficient boilers, you'll appreciate the exclusive Æ features that assure you automatic steam generation with consistently thorough combustion at low operating cost.

Its efficient performance has saved thousands of dollars for scores of owners in many types of businesses. Reduce *your* boiler room costs with the Æ Perfect Spread Stoker. Investigate now. Write for descriptive booklet today!

PERFECT SPREAD STOKER

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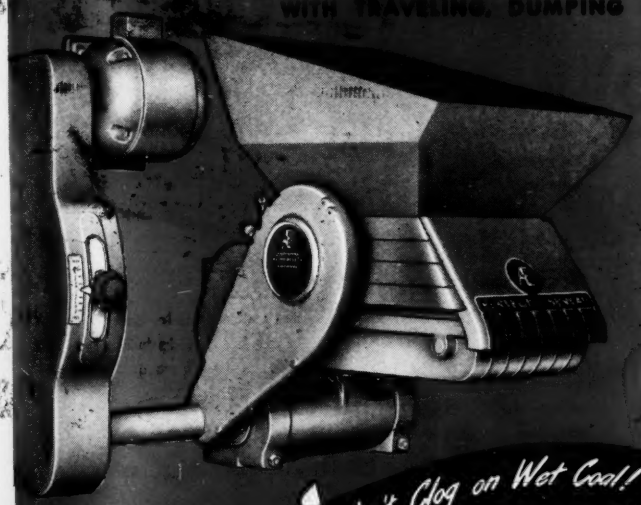
WITH TRAVELING, DUMPING OR STATIONARY GRATES



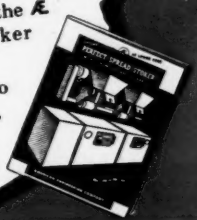
ALWAYS PLENTY OF STEAM —AUTOMATICALLY

The Æ Perfect Spread Stoker responds immediately through automatic controls to sudden and extreme changes in the steam load. It can run from a banked fire to more than twice the normal rating in a few minutes. Gets steam up fast and keeps it there!

Won't Clog on Wet Coal!

FREE—Get this valuable descriptive booklet on the Æ Perfect Spread Stoker today!

Address inquiries to 8 Aramingo Ave., Philadelphia 25, Pa.



Other Æ Products: Æ-TAYLOR STOKERS, LO-HED HOISTS, MARINE DECK AUXILIARIES, HELM-SHAW FLUID POWER

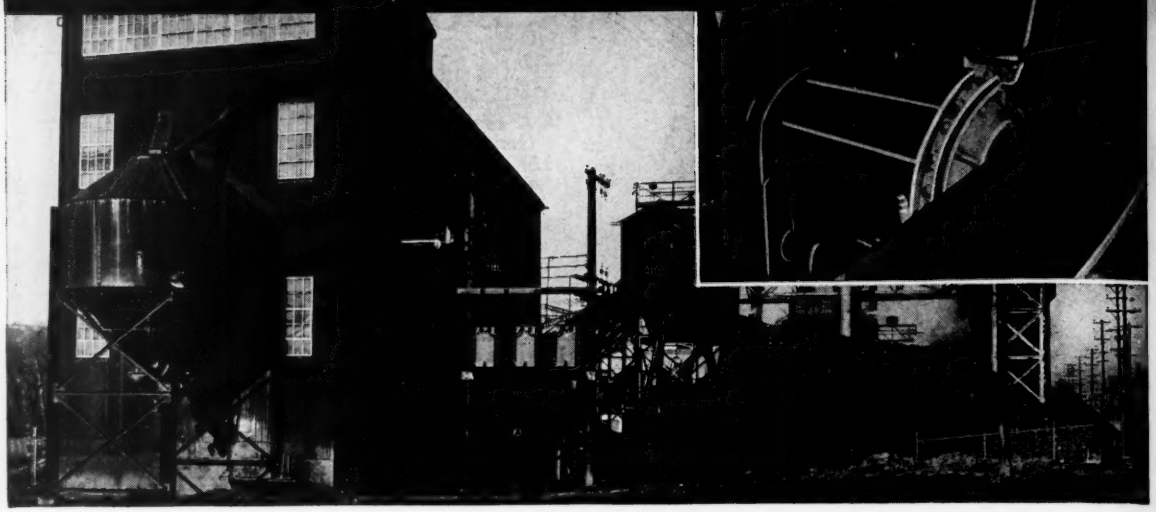
AMERICAN ENGINEERING COMPANY

2408 ARAMINGO AVENUE • PHILADELPHIA 25, PA.

THERE'S EFFICIENT, LOW COST COAL PREPARATION

Wherever there is an AMERICAN CRUSHER...

COAL IS SPLIT -NOT CRUSHED



At the Windsor Power House Coal Co., Power, W. Va., preparation plant shown above, the American Rolling Ring Crusher Model 42S (in insert) is in daily operation reducing 5 x ¾" coal to —¾" at the rate of 230 TPH.

Throughout the country, in the many plants with American Crusher installations, you'll find efficient coal crushing resulting in efficient firing.

American Rolling Ring Crushers, with their patented shredder ring action which *splits coal instead of crushing it,* assures uniform sizing. Fines are controlled to a minimum or maximum and no oversize is passed. The crushed product is a constant yield of stoker or pulverizer size.

The *total operating cost* of Americans is *less than 1c per ton.*

The American "S" Crusher for power plants is a compact, complete crushing operation which is installed in minimum head room without extensive conversion and with no auxiliary crushing facilities.
There is an American Rolling Ring Crusher to fit your needs. Capacities up to 500 TPH.

Write for Bulletin "Crushing Coal at Less Than One Cent a Ton"

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

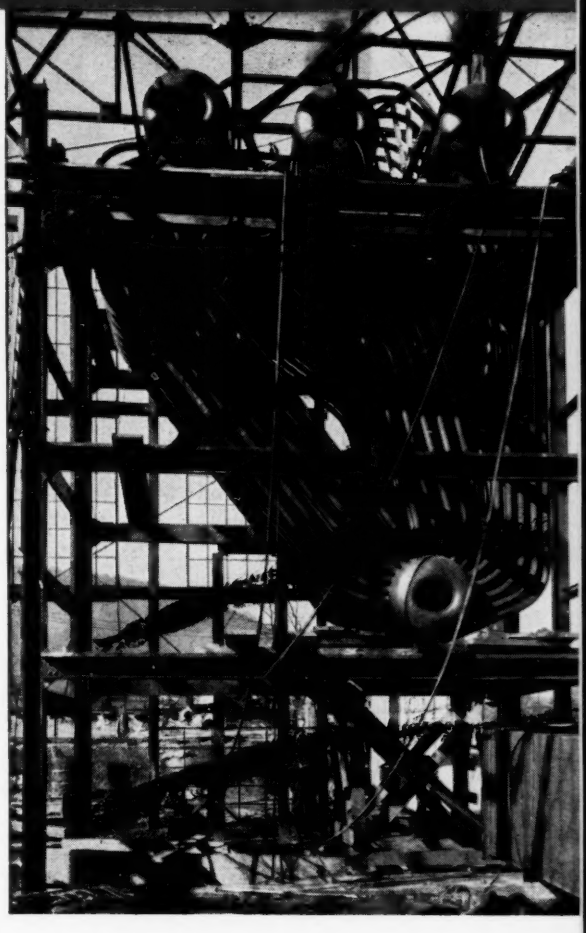
1429 Macklind Avenue
St. Louis 10, Mo.

DOWELL

SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Remove Mill Scale

THE CHEMICAL WAY!



CHEMICAL CLEANING SERVICE PROTECTS NEW BOILERS!

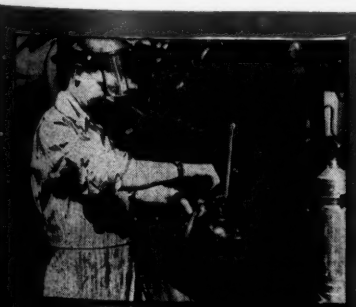
Many power engineers have found that the Dowell chemical method of removing mill scale from new boilers before the first firing results in more satisfactory boiler operation.

Dowell engineers fill the new boiler with specially selected liquid solvents designed to dissolve the mill scale. Unless removed, mill scale may retard heat transfer, slough off particles which abrade the system during operation, and act as a base for further corrosion. Dowell brings all necessary chemicals to the job in truck-mounted tanks and furnishes pumps, mixers, heaters and control equipment.

The chemical removal of mill scale *after* equipment erection can eliminate much of the extra care required in the handling of previously sand-blasted or pickled tubes. It may also substitute satisfactorily for the grease-removing alkaline pre-boil. Call or write Dowell for an estimate of the cost of Chemical Scale Removal Service for your heat exchange equipment.

DOWELL INCORPORATED • TULSA 3, OKLAHOMA

New York, Philadelphia, Boston, Baltimore, Pittsburgh, Buffalo, Cleveland, Cincinnati, Detroit, Chicago, St. Louis, Kansas City, Wichita, Oklahoma City, Houston, Fort Worth, Shreveport, Mt. Pleasant, Michigan; Salem, Ill.; Borger, Texas; Wichita Falls, Texas; Midland, Texas; Lafayette, La.; Long Beach, Casper: Dowell Associate—International Cementers, Inc.



DOWELL

FOR INDUSTRIAL CHEMICAL SERVICE

Cold Facts...

...ON LUBRICANT PERFORMANCE

This special refrigerating apparatus at Sinclair Laboratories tells an important story every day to research experts and refinery control technicians.

The thermometers, shown above inserted in lubricating oil samples, record temperature as cold is increased in the special refrigerating apparatus. Trained observers check the samples frequently, test for pour point. Sinclair, thus, makes sure that its lubricants retain full protective qualities even at sub-zero temperatures . . . when your specific application demands.

Such constant manufacturing control and research assures you that famous Sinclair lubricants . . . and all new Sinclair products . . . will give outstanding performance to meet your most exacting requirements.

Sinclair Lubricants for the Power Plant

For Turbines:
SINTURLITE OILS
For Steam Cylinders:
SINCLAIR STEAM CYLINDER AND VALVE OILS
For Compressors:
RUBILENE OILS
For General Lubrication:
COMMANDER OILS
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You keep air and fuel rates in accurately measured proportion to each other and in direct relation to the plant load, when you use Hays Automatic Combustion Control.

The result is simple and exceedingly profitable—you operate your boilers closer to their maximum capacity; and do it safely, much more economically than is possible under manual operation. You actually **stretch** your plant's steam capacity.

This is the truly modern system—wholly electrical: sensitive to the slightest change in steam demand, telegraphic in its instant measure of each variation and in its corrective response. It is simple to install, to maintain, to operate.

You recognize the advantages—steam pressure maintained constant, turbine room efficiency improved, and quality of processed product protected; fuel and maintenance costs appreciably lowered; clinker trouble greatly lessened; smoke negligible.

How you may enjoy these advantages is explained in Bulletin 46-605—contains helpful schematic drawings of 14 typical installations. Better send for it.

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Automatic COMBUSTION CONTROL

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NEW EQUIPMENT NEWS

Use the coupon below when you want further information on the equipment described on this page and following pages. Write the identifying letter or letters in the space provided, clip the coupon and send it to Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Illinois

A Dual-Pressure Air Compressor. To fill a need by users of small amounts of compressed air, Kellogg Division, American Brake Shoe Co., has developed a new dual-pressure air compressor which can handle an extremely wide variety of jobs. Initial response to this new design indicates that many small industries may find, in its exceptional economy and flexibility, a better answer to their compressed air problems.

Although this compressor is basically a standard single ½ hp compressor, operating at the cost of one

unit, is provides the performance characteristics of two separate compressors—2.4 cfm of free air at 50 psi and 1.2 cfm of free air at 150 psi. Change in pressure and volume is effected by means of an ingenious assembly, consisting of an automatic motor pulley and sliding motor base. A hand lever moves this assembly, while the compressor is running, from one pressure position to the other, varying the motor speed and controlling the pressure through contact with a low pressure unloader valve.

When the lever is set at 50 psi the automatic motor pulley is increased in pitch diameter, thus operating the pump at increased speed and delivering a higher volume of air. In this position the sliding motor base permits the low pressure unloader valve to unload at 50 lb pressure, unloading the tank, and allowing the compressor to run continuously.

B Engine-Driven Welder. A new Flexarc lightweight engine-driven welder, designed for 200 amp at 30 v on the basis of 50 per cent duty cycle, is available from Westinghouse Electric Corp. Each welder comes with accessories complete ready to weld, including work and electrode leads, helmet, electrode holder, a liberal supply of electrodes and a wire scratch brush.

Dubbed "The Ranger," this d-c welder can be towed anywhere a jeep can take it. The design characteristics of the generator provide easy striking and maintenance of the arc for shop quality welding on steel, cast iron, alloys, hard surfacing aluminum and brass.

The generator is direct-connected to a Hercules IXB engine. The welding current is adjusted over a wide range from 30 amp at 20 v to 250 amp at 30 v in four major steps by plugging screw locking plugs on work and rheostat control. Polarity is positively controlled by interchanging work or electrode lead connection. Available either as a portable or stationary model.

C Temperature Regulator. To provide a means of securing accurate, reliable temperature control at reasonable cost, Leslie Co. has developed a new self-acting, temperature regulator designated as Class "T."

Important features include single seated construction in all sizes ½ in. to 4 in. for steam pressures up to 125 psi, packless main valve stem,

hard faced seating surface and hardened wearing parts, liquid-filled thermostatic element, all of which assure positive control response to small temperature changes, positive dead-end shut-off, long life and simple maintenance.

Accurate temperature control can now be obtained at reasonable cost for many industrial applications, including heating water for wash rooms, laundries, chemical and food process equipment, etc.

D Leather V-Belt. Leather V-belting which can be cut from a roll and spliced to fit any required centers is now available from the Chas. A. Schieren Co.

This V-belt is made in A, B, C and D sections and is supplied in 100 ft rolls, packed in boxes. The belt is constructed in such a way that the side walls are of flat, full grain leather which provides greater pulley gripping capacity. These leather V-belts are not affected by oil, states the manufacturer.

The belt can be made endless, to fit any drive, either by a lapped splice or by mechanical fasteners. By using a lap press and tension rods and clamps, which are also available from Chas. A Schieren Co., the belt can be installed endless under any desired tension directly in the grooves on the drive. This saves tearing down drives that have outboard bearings.

The Schieren E-Z Lap Cutter,

POWER PLANT ENGINEERING

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Fig. 1640
"King Clip" Gate

Fig. 2228
200 lb. Bronze
Union Bonnet Gate

With Lunkenheimer Valves in the line . . . you get better valve service . . . every time. That's the considered opinion of engineers and operating men throughout the nation. From long experience, they know that Lunkenheimer Valves give **extra** years of **better** service, set new low records for over-all valve cost.

Lunkenheimer leadership in engineering and design, valve metallurgy and craftsmanship has been established over many years . . . protected by rigidly enforced standards of highest quality . . . recognized by valve users in practically every industry. When buying valves, the Lunkenheimer name is your assurance of full service . . . complete satisfaction.

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A big stock is not enough. Lunkenheimer Distributor stocks are carefully geared to the particular needs of each territory. This "planning ahead," plus your Distributor's aid in solving operating and maintenance problems, rapid delivery service are the reasons why so many plants rely on their Lunkenheimer Distributors for complete valve service.

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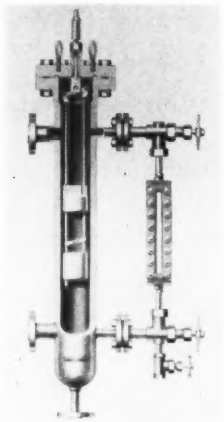
described as a mistake-proof belt chopping device, also supplied by the company, enables anyone to splice a leather V-belt to factory perfection. It cuts the leather on the bias across the belt, making a long, tapering, slant-wise cut, producing the fine feather edge on the ends so necessary to a smooth-running endless belt joint.

Leather V-belting for fractional horsepower drives is also available. It is made in ¼ in., 5/16 in., ⅜ in. and ½ in. sizes and is supplied in spools holding 100 ft. It is joined by hooks, the same as round belting.

E Water Column. Jerguson Gage & Valve Co.'s new water column, for low water and high water alarm, has independent knife-edges that guarantee, according to the manufacturer, exceptional efficiency.

Quick, positive action is imperative in a water column in order to give the operator immediate warning of too high or too low water level in the boiler. To insure such action, Jerguson engineers made exhaustive experiments, according to James Ford,



Sales Manager, resulting in development of the simplified knife-edge and single lever construction.

This means that the solid type displacement weights balance on stainless steel knife-edge supports, which are carefully hardened to insure long, trouble-free service. This delicate balance responds immediately to changes in boiler water level. The alarm mechanism is stainless steel throughout, an important additional protection against rust and wear.

New Jerguson water columns are available in five models, 300 lb, 450 lb, 600 lb, 900 lb, and 1500 lb. A complete printed analysis of the construction, operation, and application of the Jerguson Water Column is now ready, and will be mailed out, without obligation, on request.

F Hot Water Boilers. Hook & Ackerman, Inc., announces the addition of two new and larger size models to their line of Hydrotherm Automatic Gas Fired Central Heating Plants for small installations.

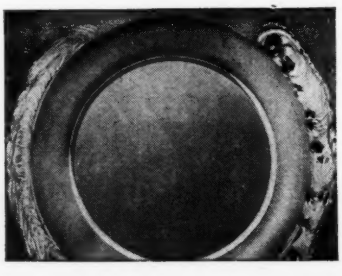
The two larger units have capacities of 600 sq. ft. installed radiation and 1000 sq. ft. installed radiation which have received full AGA approval for use on manufactured, natural and mixed gas, as well as for Butane, Propane, and Butane Air Mix. Available to the trade immediately, these larger size boilers meet the current need for volume water heating for apartment houses, hotels, laundries, industrial and commercial buildings.

All other Hydrotherms of various capacities, including the two larger models, feature the patented horizontal heat exchanger that makes the units extremely compact and highly efficient.

G Improved Electrode. The Air Reduction Sales Co. has announced the availability of an improved Airco No. 312 electrode. Originally placed on the market two years ago, it is an all-position, mild steel electrode designed to produce weld metal possessing not only excellent mechanical properties, but also low hydrogen content.

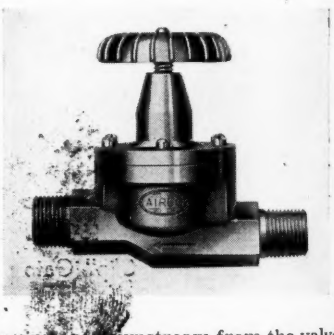
According to the manufacturer, the improved Airco 312 electrode has two advantages over its predecessor: 1. It can now be used on a-c and d-c reverse polarity current. Operating characteristics are said to be equally good on either a-c or d-c reverse. The former 312 electrode could be used only on d-c reverse. 2. Preheating of the electrode is no longer required with the improved Airco 312 to obtain porosity-free weld deposits. These deposits can be obtained by using either the stringer bead or the full weave technique.

The recommended uses for the improved Airco 312 are: welding high sulphur, free machining steels; welding hardenable steels where no preheat is used; welding cold rolled steels which normally exhibit excessive porosity when welded with conventional electrodes; weldments to be vitreous enameled after welding. The extreme low hydrogen content of the improved Airco 312 makes possible the production of satisfactorily enameled surfaces without any heat treatment prior to enameling.



H Station Outlet Valves. Air Reduction Sales Co. recently announced the availability of its new ½-in. station outlet valves. A product of Airco research and development, the new valve is a compact combined shut-off and check valve for use on drops or risers of a piping system. The new valve is a diaphragm type, and therefore being "packless" has no stuffing box. Performing a dual function, Airco's new station outlet valve eliminates the necessity of installing a separate shut-off valve and check valve.

As a shut-off valve it permits repairs or alterations to be made on



equipment downstream from the valve without disturbing other stations on the line; as a check valve, it allows the flow of gas in only one direction and it will close tightly should a disturbance at the torch cause a backpressure to travel as far as the valve.

J Turbine Pumps. Recently announced by Walter H. Eagan Co. these new turbine pumps are available in capacities to 250 gpm and in pressures to 200 psi. The manufacturer states that the pump is unique in that it unloads as the pressure drops, discharges liquid against relatively high pressure at low speeds and has renewable heads which facilitate quick repair and change of characteristics by a simple mechanical operation.

Other features pointed out by the

For faster, better piping jobs get everything from CRANE

An all-Crane installation! That's a sure way to keep piping jobs moving swiftly and smoothly—from design to erection to maintenance. Crane quality throughout—in valves, fittings, pipe, accessories, and fabricated piping—makes dependable performance a foregone conclusion.

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Look at this steam header installation for example. Every piping item is from Crane. That means all the benefits of standardization . . . all the benefits of this 3-way advantage:

ONE SOURCE OF SUPPLY offering the world's most complete selection of steel, iron, brass and alloy piping materials for all power, process, and general service applications.

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OUTSTANDING QUALITY in every item—assuring uniform dependability and durability in every part of piping systems.

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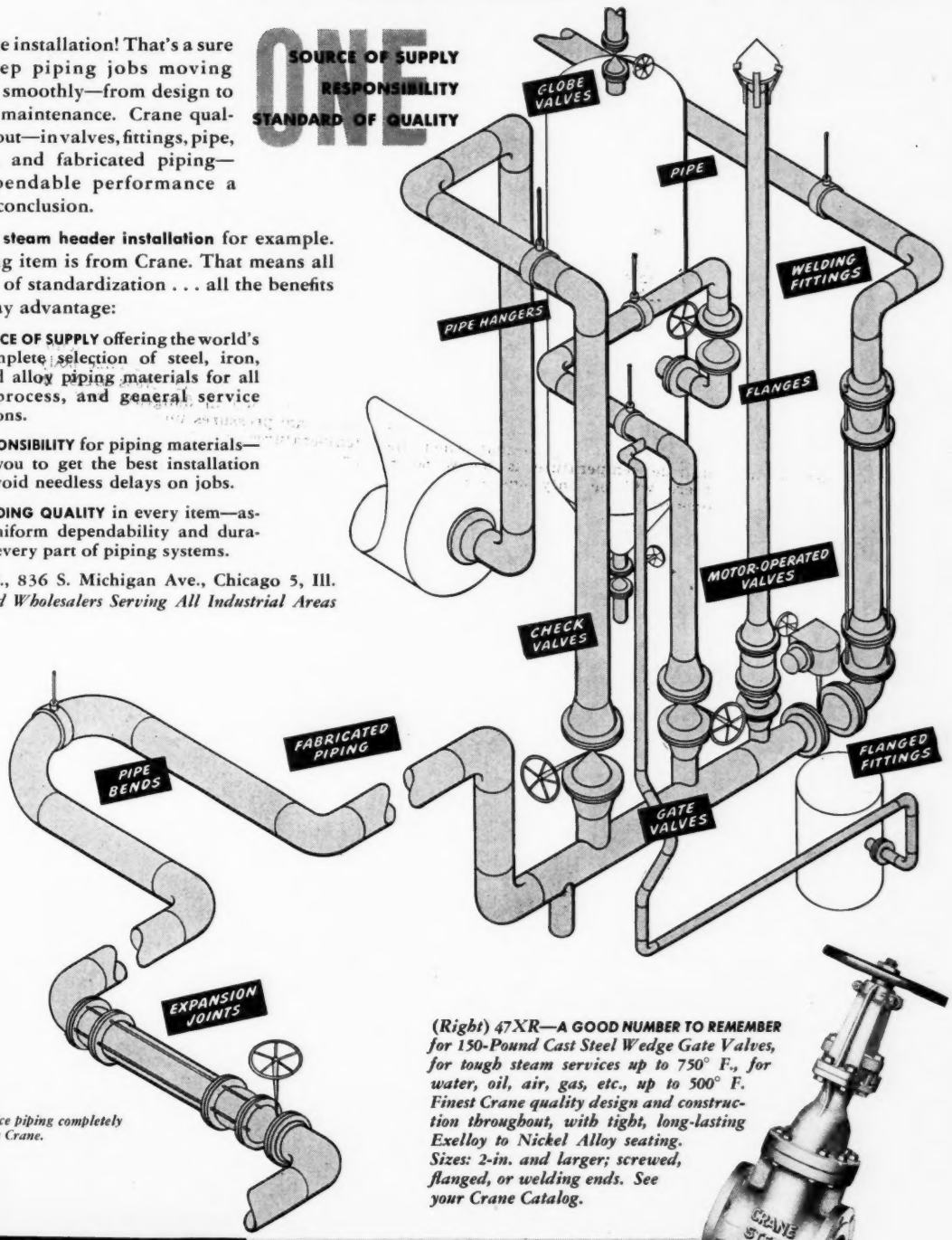

Steam service piping completely equipped by Crane.

(Right) **47XR—A GOOD NUMBER TO REMEMBER** *for 150-Pound Cast Steel Wedge Gate Valves, for tough steam services up to 750° F., for water, oil, air, gas, etc., up to 500° F. Finest Crane quality design and construction throughout, with tight, long-lasting Exelloy to Nickel Alloy seating. Sizes: 2-in. and larger; screwed, flanged, or welding ends. See your Crane Catalog.*

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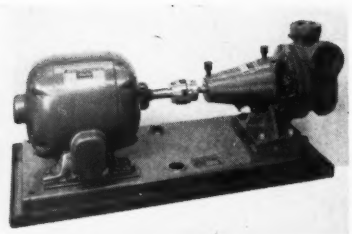
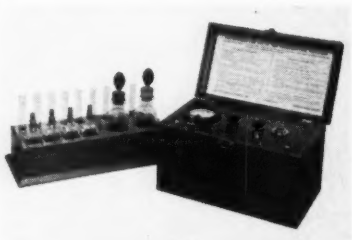


manufacturer for this unit are: Continuous, non-pulsating flow; reduction in power on drop in head; handling of non-lubricating fluids at high temperatures; self-priming; high heads at relatively low capacities, high efficiencies and low speeds.

The pump is designed for use with clean liquids up to 500 SSU viscosity and is particularly suited to hot and volatile liquids.

K Boiler Water Tester. Barclay Chemical Co., Inc., has announced its new Photoelectric Analyzer designed for the rapid determination of phosphate and sulphate in boiler water. The manufacturer points out that the daily tests of samples of boiler water, now so necessary for the continuous and safe operation of present-day boiler plants, can be greatly simplified by the use of this new instrument.

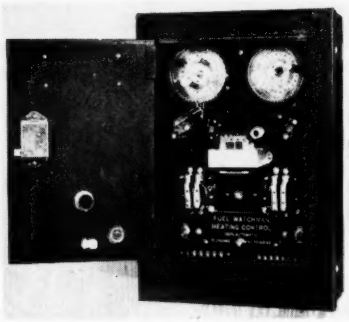


The procedure is said to be very simple. To a measured quantity of filtered boiler water sample reagents are added which cause a blue color to be developed, the depth of color being in direct relation to the amount of phosphate present. This sample is then placed in the instrument where the photoelectric cell is energized and the parts per million of phosphate read directly on the specially calibrated meter. A similar procedure, using other reagents, will give sulphate determination.

L Heating Control. The "Fuel Watchman," a new heating control announced recently by The Fuel Watchman Co., is said to be based on an entirely new principle. Once installed and adjusted, it is pointed out, the Fuel Watchman takes care of heating needs regardless of the outside temperature. It takes care of nightly and seasonal start-ups without attention.

The unit consists of a roof control, an outside control and the main control panel. The roof control is located where it will receive the direct rays from the sun for the greatest length of time. Its purpose is to determine the amount and effect of color radiation being absorbed by the building and prevent overheating on mild days.

The outside control is so adjusted at the factory that each operation occurs over a different range in temperature. No adjustment is required when it is installed. This control is mounted on the shady side of the building about 6 ft off the ground and protected from the sun. The main



control panel is mounted in the boiler room. The heart of the control consists of two Telechron synchronous motor clocks on which are mounted six schedule discs. Each disc is notched to correspond to one outside thermostat setting so that when the outside temperature is below 60 F there will be only one schedule in operation at a time.

M New Electrode. Ampco Metal, Inc., announces a new silicon bronze arc welding electrode, "Sil-Trode". It was developed especially to meet the needs of welding engineers who prefer to use an electrode of similar composition to the parent metal when fabricating and repairing silicon bronze parts.

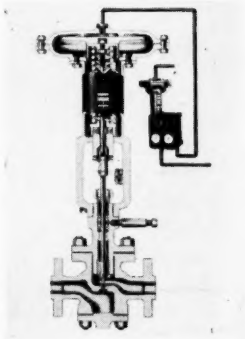
Sil-Trode is a shielded-arc silicon bronze electrode operating on reverse (positive) polarity, direct current. The coating and core wire were specifically designed to produce a spray type arc action, low spatter loss, free-flowing slag, and weld metal producing crack-free, smooth, dense deposits. The slag is friable and easily removed.

The special core wire selected for use in the Sil-Trode was carefully developed so that the electrode could be used in joining any of the present weldable grades of silicon bronze sheet and plate available for fabricated tanks, chemical processing equipment, etc.

Sil-Trode will be available in 3/32 in., ⅛ in., 5/32 in., 3/16 in. and ¼ in diameter sizes and packed in 50 lb containers.

N Regulating Valves. Leslie Co. has announced a new design feature in its Class DL and DLS Diaphragm Regulating Valves with "Conden-Seal" cooling bonnet for use with air or water operated Controllers.

Salient features include: Single seated, tight closing main valves; hardened stainless steel valves, stems and guides, and integral hard surfaced seats; valve-above-seat position for reverse or direct acting valves; easy reversal of valve action by a simple change of diaphragm superstructure; "Conden-Seal" cooling bonnet which includes a stainless steel radiating tube and a condensate res-

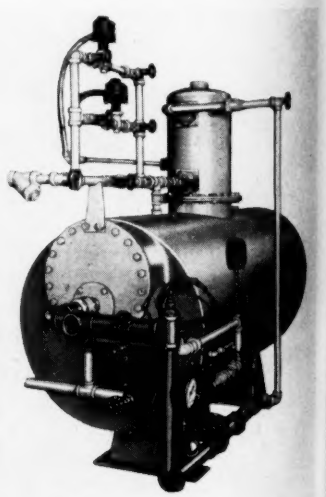


ervoir for steam service to protect the low friction packing gland at temperatures above 450 F; sensititve diaphragm assembly which maintains constant effective area throughout travel.

The Class DL is available in semi-steel (125 lb flanges) or bronze body (300 lb flanges); the Class DLS, in cast steel (600 lb flanges). Suitable for steam pressures up to 600 psi and temperatures up to 800 F and for pressure drop across the main valve as high as 300 psi in the smaller sizes.

O Deaerator Type Feedwater Heater. Effective mechanical deaeration of boiler feedwater with oxygen reduction to less than 0.06 cc per liter is announced by Fred H. Schaub Engineering Co., Inc., in their deaerator type feedwater heater. The process consists of pre-heating above the boiling point of all feedwater which enters the deaerator receiver, and the diffusing of the water under pressure through a series of spray nozzles which spray the water into a very fine film.

There are several variations of the Deararator System which can be readily incorporated into any open type return system. Extensive use of alloys and corrosion-resistant mate-



GETTING MORE LOW-COST STEAM

Greater steaming capacity for longer periods of uninterrupted service is assured by using a CARBOFRAX silicon carbide brick boiler setting. Its use improves overall efficiency —effects noteworthy operating economy—lowers maintenance costs.

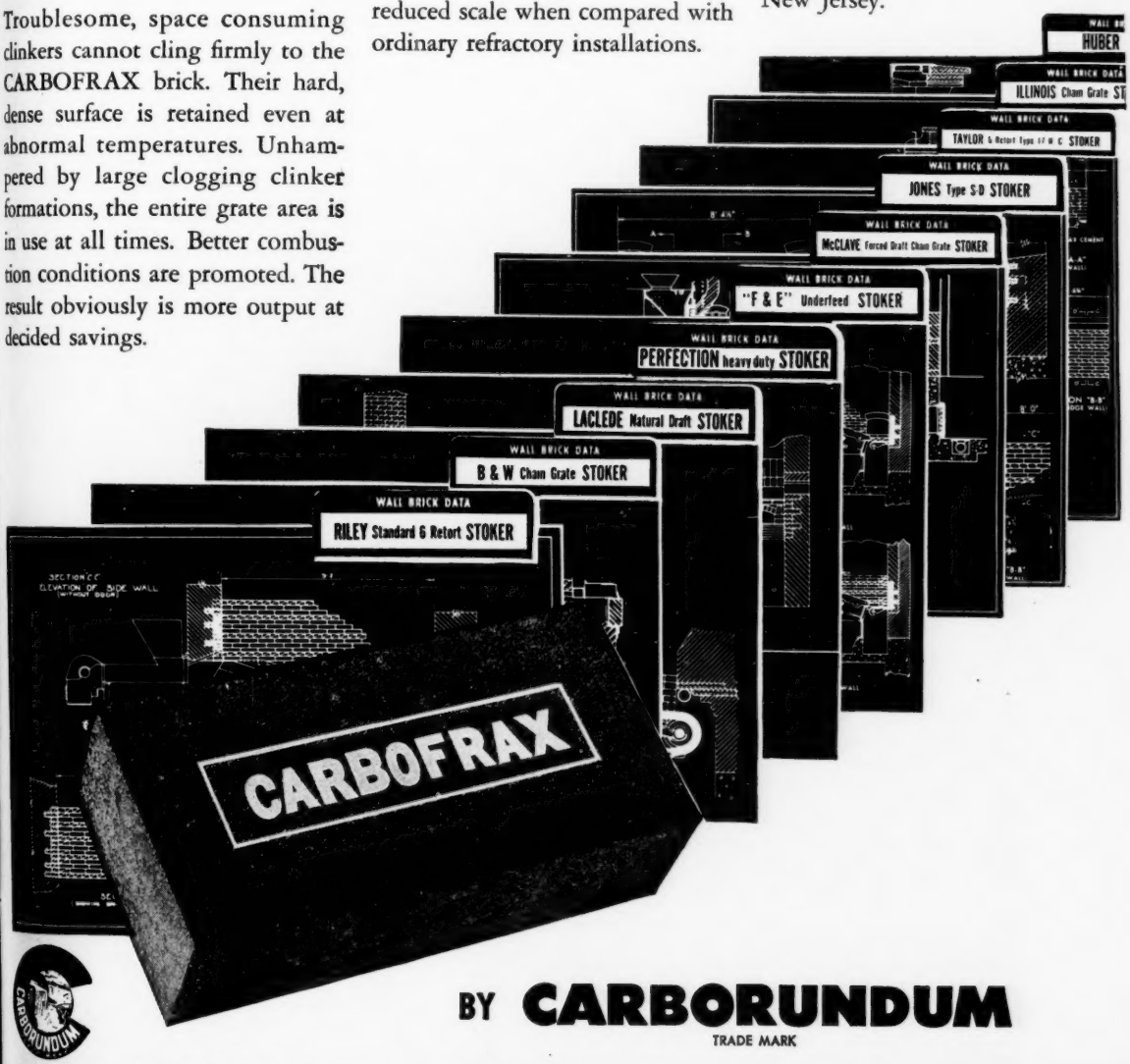
Troublesome, space consuming clinkers cannot cling firmly to the CARBOFRAX brick. Their hard, dense surface is retained even at abnormal temperatures. Unhampered by large clogging clinker formations, the entire grate area is in use at all times. Better combustion conditions are promoted. The result obviously is more output at decided savings.

Service life of 8 to 10 years from CARBOFRAX brick without replacement is regularly reported. Outages for setting repairs are rare because of the extreme resistance to abrasion, spalling and cracking possessed by these brick. Any maintenance expense is on a greatly reduced scale when compared with ordinary refractory installations.

Further savings are realized from the longer life of the upper walls. Being firmly supported by the erosion resistant CARBOFRAX setting, these walls do not require frequent rebuilding or replacement.

It will pay you to discuss more fully the benefits of a CARBOFRAX setting for your boiler furnace. We will be glad to supply the details. To get a preliminary summary of pertinent facts, write Dept. H-117 for your copy of our illustrated technical booklet.

The Carborundum Company, Refractories Division, Perth Amboy, New Jersey.



BY **CARBORUNDUM**
TRADE MARK

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rials reduce maintenance to the minimum. Completely automatic equipment includes gages, thermostats, and regulators, as well as the vent condenser and spray header. It is available in sizes from 100 to 1000 hp.

P Seatless Valve. The "20th Century Seatless Valve" just announced by Knowles-Fisher Corp., incorporates a design which is without a valve seat or washer.

The valve opens and closes with a flick of the fingers, without mechanical pressure. It cannot jam, and no

dirt, scale or abrasive can affect its operation or reduce its efficiency.

The announcement points out the following features: The shut-off is positive. No gland packing is necessary. No fluid can come in contact with the threads. Operation is smooth, quiet. There can be no hammering or chattering, as pressure builds up gradually.

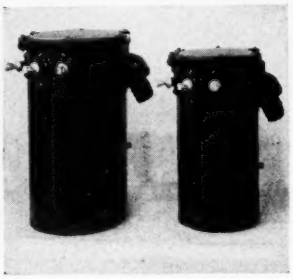
Q New Decarbonator. Built in four sizes for capacities up to 1800 gph, the new Model CDC Decarbonator has been added to Cochrane Corp's. Decarbonator line. Water to the unit, controlled by a pilot-actuated regulating valve, is distributed over a packed tower. A motor-driven blower in a spool on top of the corrosion-resistant plastic-coated welded steel shell draws air up through the tower counterflow to the water thereby scrubbing the water free of carbon dioxide. A filter in the air inlet prevents contamination of the water with dust.

The Decarbonator is regularly used to remove carbon dioxide from the effluent of demineralizing systems, carbonaceous hydrogen zeolite softeners, and from water supplies treated with acid.

R Distribution Transformers. An improved line of smaller, lighter and more compact distribution transformers made possible by the use of preferred orientation electrical core steel, has been announced by Allis-Chalmers Mfg. Co. The new design represents a 17 to 46 per cent saving in weight with corresponding reduction in size.

Engineered to meet all the recommendations included in the revised second report of the EEI - NEMA Joint Committee on the standardization of distribution transformers from 1½ to 100 kva, 2,400 through 15,000 v classes, the improved transformers represent the latest development in the electrical field as well as the latest advancements in metal fabrication and welding.

Features of the new units include spray Bonderized steel tanks with machine welded seams to insure permanent protection against leaks; high voltage pockets fabricated from a single piece of special deep-drawing steel permanently welded to the tank wall; recessed tank bottoms to provide additional protection against rusting and mechanical damages in

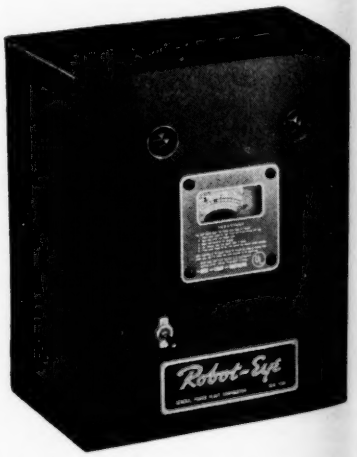


handling, and low voltage bushings mounted with a gasketed point which is held in compression by a pressed steel gasket ring. This ring can be easily removed at installation for replacement of L.V. bushings, if necessary, without opening the transformer.

Other features include standard flat-slotted lugs on internal low voltage leads which allow quick change from series to parallel or vice-versa, the use of preferred orientation electrical steel for efficient core type construction, and re-design to reduce copper-to-oil temperature gradients to a minimum, resulting in better short time overload characteristics.

The improved spray Bonderized transformers are given three coats of quality paint, each of which is baked on separately. This provides protection against severe weather conditions, salt and corrosive acid atmosphere.

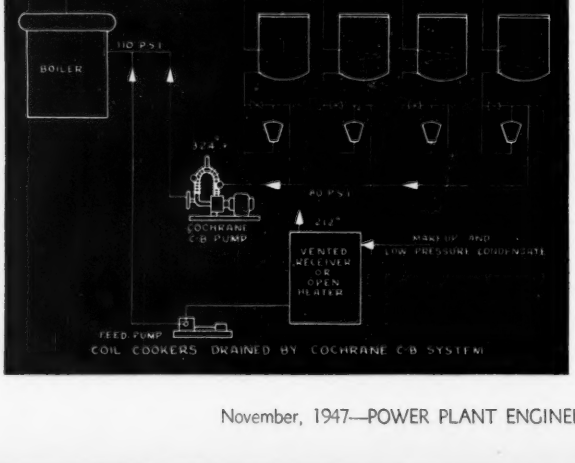
S Combustion Control. This new electronic combustion control, called Robot Eye, is described by the company as a practical and inexpensive control directly responsive to the products of combustion in the flue gas. It is said to be particularly adapted to the use with rotary cup burners permitting operation at high levels of efficiency. Advantages of the unit, as listed by the manufacturer, General Power Plant Corp., are: reduction of fuel oil consumption, continuous high efficiency of operation, minimization of smoke formation, elimination of guesswork in calculating efficiency, reduction of maintenance costs.



Its method of operation is described as follows: Combustion gases leaving the furnace pass between a photoelectric cell and an energizing lamp mounted on opposite sides of the breeching. Fluctuations in haze density present in the breeching cause variations in the current generated by the photoelectric cell. This current is indicated on the microammeter in the control panel. Through translation equipment the position of the microammeter needle determines the direction, magnitude and speed of movement of a reversible motor controlling the admission of air to the furnace.

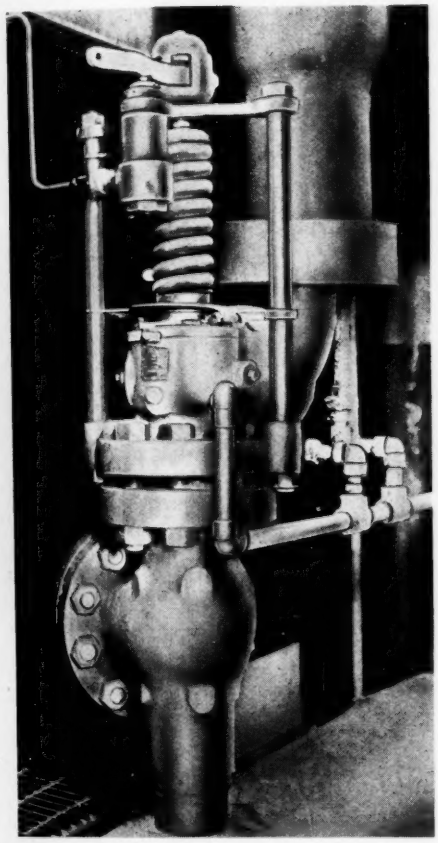
T Ni-Resist Gate Valves Back. Crane Co. announces the reinstatement of its line of Ni-Resist Cast Iron Gate Valves, which was discontinued prior to the war.

The valves are of the wedge disc, outside screw and yoke type and are being regularly furnished with



Give Your Boilers a Break!

End Safety Valve Troubles by Installing FOSTER 38-SV Safety Valves with these 5 GUARANTEED ADVANTAGES:



Hundreds of Foster 38-SV Safety Valves are giving top performance in important installations. This 2½" superheater unloading valve operates at 1450 lb., 950° total temp. Others are in service up to 2575 lb. at 1000° F.

1 Built to Stay on the Job—the Foster 38-SV is the SAFETY valve that is built to pop without causing boiler outages. On accelerated tests in an Eastern Utility, one of these valves has been popped every day for more than 6 years. It has had only routine maintenance, and yet it pops consistently at set pressure, and does not leak. In the Chief Engineer's own words—this is the equivalent of at least 40 years' normal service.

2 Accurate Popping—Once set at the desired popping point, the Foster 38-SV pops on the button for each successive pop. For instance, in another Utility installation, the 38-SV under test was set for 600 lb. and popped 50 times in quick succession. The first pop was at 600 lb. and the 50th pop was at 595 lb. In spite of the heat of this abnormal operation, the Foster 38-SV was thrown off less than 1%. After a short cooling period, it again popped at 600 lb. That's test gauge accuracy!

3 Minimum Blow-down—Foster 38-SV's are adjustable so they can be set to reseat when pressure has dropped as little as 1% below the popping point. In this same test the 38-SV, on its first pop, reseated at 594 lb. for a 6 lb. or 1% blow-down. On the 50th pop, it reseated at 589 lb. which is also 6 lb. or 1%. After each pop, it reseated positively with no chattering or leakage. Only over-pressure up the stack—no useful steam wasted.

4 High Relief Capacity—Foster 38-SV's have larger bore because they can handle larger volume of steam and still control blow-down. Depending on operating conditions, they may give more than twice the capacity of other makes, as in the case of 5 Foster 38-SV's required to replace 12 "conventional" safety valves of the same nominal size. Fewer valves to buy—fewer valves to service.

5 Low Maintenance—Hot or cold, the piston in the 38-SV fits loosely and cannot stick, and yet no steam reaches the spring. The spring stays cool enough to touch, even while the valve is popping—which means longer spring life. Disc and seat expand at the same rate during heating-cooling cycles—there is no drag to destroy seating surfaces. Simmering and chattering have been eliminated as a source of destruction. Discs will not warp or crack. When routine inspection and maintenance are indicated, complete loading assembly lifts out without disturbing the spring setting.

For full details on the design and construction features that enable this valve to outperform any other safety valve, get in touch with your Foster Representative or with us direct.

FOSTER ENGINEERING Company

PRESSURE REGULATORS...RELIEF AND BACK PRESSURE VALVES...AUTOMATIC STOP AND CHECK VALVES...ALTITUDE VALVES...DAMPER REGULATORS...FAN ENGINE REGULATORS...PUMP GOVERNORS...TEMPERATURE REGULATORS...LIQUID LEVEL CONTROLLERS...FLOAT AND LEVER BALANCED VALVES...NON-RETURN AND TRIPLE DUTY VALVES...VACUUM REGULATORS OR BREAKERS...SIGHT FLOW BOXES...STRAINERS...SAFETY VALVES...SIRENS

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screwed ends in sizes from ½ to 2 in. and with flanged ends in sizes from 1 to 8 in. All valves in sizes 3 in. and smaller have the clamp type bolted bonnet and sizes 4 to 8 in. inclusive have the conventional type of bolted bonnet.

Body and bonnet of all valves, the disc in sizes 4 in. and larger, and the gland in sizes 3 in. and smaller are made of Ni-Resist. The strength and physical characteristics of Ni-Resist are about the same as those of cast iron; but resistance to erosion and wear is definitely superior to that of cast iron, and corrosion resistance is substantially better.

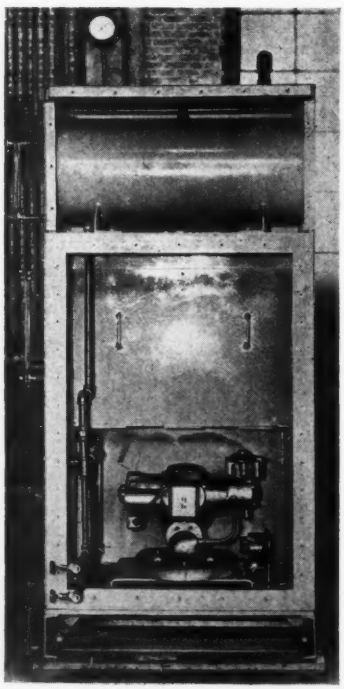
To add to their corrosion resistance, the stem and body seat rings, the disc in sizes 3 in. and smaller, and the disc facings in sizes 4 in. and larger are made of Crane 18-8 alloy steel.

U Waste Heat Boiler. Fully self-contained and very compact, an exhaust waste heat boiler has been developed by American Locomotive Co.

Enclosed in an insulated steel cabinet, the unit functions automatically on exhaust gases from a turbocharged Diesel engine, or it can be operated by household type oil burner.

The waste heat boiler is designed to generate 500 lb of steam per hour on the Diesel exhaust and considerably in excess of that figure when operating on the oil burner.

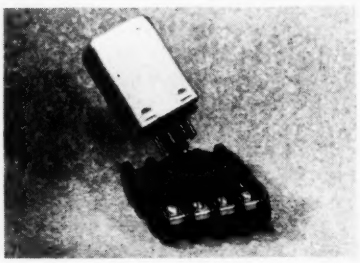
Exhaust gases of 600 to 800 F coming from the Diesel engine run the unit as long as the engine functions. When the engine is shut down, the oil burner is cut in by a few simple steps, so that there is almost no interruption in the boiler's operation, and no break at all in the heating service. When no heat is required, the boiler can be run dry, acting as a muffler to the Diesel engine.



The boiler features strict safety precautions. When the engine is operating, the oil burner in the boiler cannot be turned on accidentally. The oil burner combustion chamber is lined with refractory at the plant.

V Relay. A significant application for a low-cost, totally-enclosed relay has been reported by the manufacturer, Sigma Instruments, Inc.

A widely used, effective, and inexpensive means of accurate temperature control consists of a sensitive mercury thermostat which switches



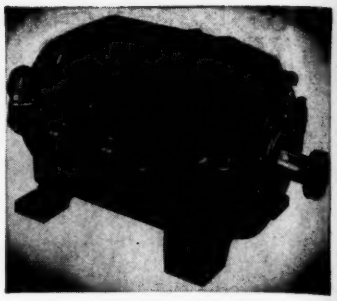
the coil circuit of a relay, the relay in turn controlling the load.

Satisfactory long life from the thermostat requires that the current carried by the tiny electrodes to be kept to a minimum, preferably below 4 milliamperes at 115 v a-c. It is desirable that a-c current be used to minimize plating of the electrodes and contamination of the mercury.

The Sigma Series 41 relay is ideally suited for this application. One standard type operates with only 2 milliamperes at 115 v a-c in the coil circuit. The relay contact are suitable for loads typical of this service, such as solenoid valves, incandescent indicator lamps and resistance heaters. Replacement after accidental damage or long service is made easy by plug-in mountings.

W New Mill Motors. A new line of mill motors reduced one frame size is announced by Westinghouse Electric Corp. A larger and more efficient armature that fits within the limiting dimensions of the motor frame, new roller bearings and bearing housing, and redesigned field coils make the new motor possible.

The heavy duty type MC Mill Motor is available in totally enclosed, protected self-ventilated or protected force-ventilated construction. It is built in accordance with the AISE standardized dimensions and incorporates the following features: split frame of cast steel; silicone insulated armature coil conductors; wedges of Class B material to hold coils in slots; new roller bearing and bearing housing that eliminates need of thrust washer and collars; improved field



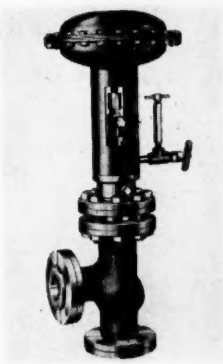
coil insulation; and rigid mounting of brush holders.

It is available in sizes from 5 to 200 hp; in voltages of 230 and 550; and in AISE dimension frames 602 to 618.

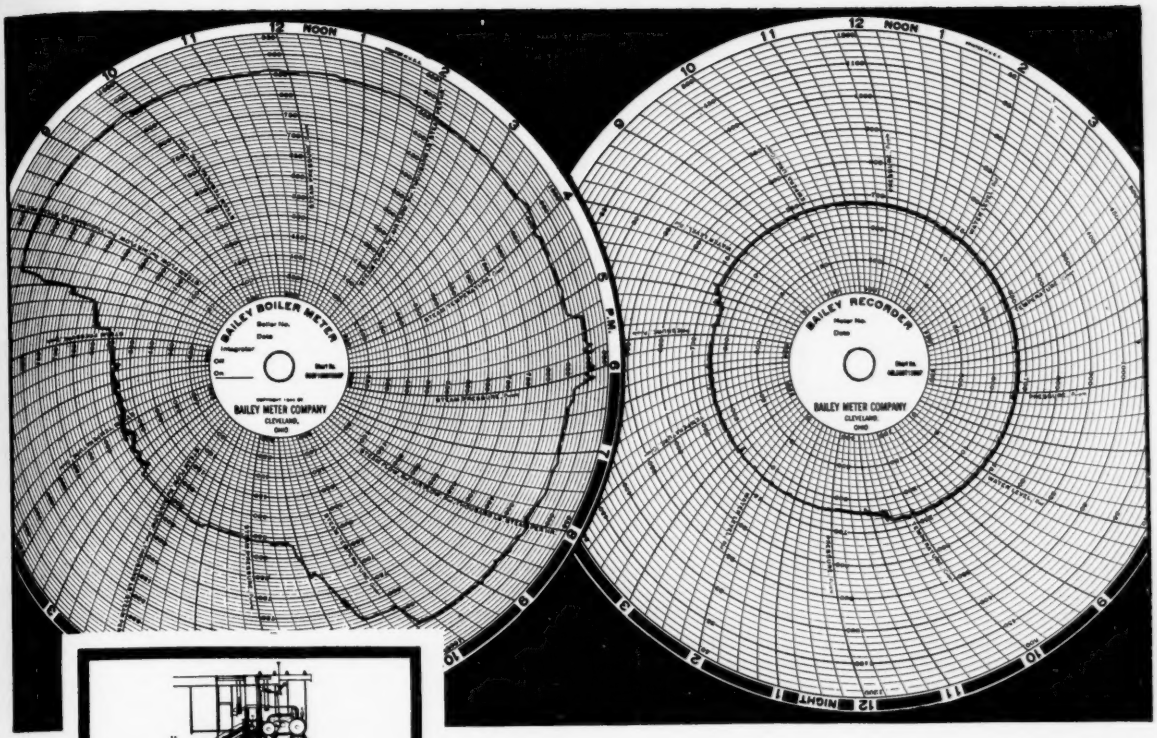
X Pyrometric Indicator. The Taco West Corp. announces the addition of a series of Precision Electrical Indicators to their line of Automatic Electronic Control Equipment. Marketed under the trade name of VERI-TELL the line includes the Model "I"—a millivoltmeter pyrometric Indicator thermally compensated, and including Briquet (Thermostatic) Automatic Cold Junction correction.

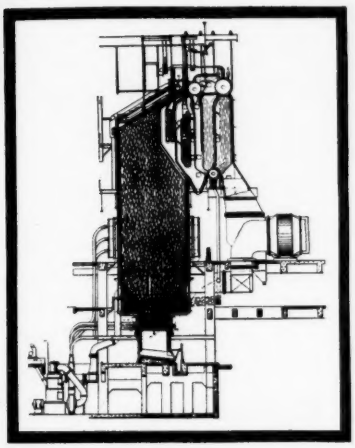
The Model "H"—millivoltmeter pyrometric Indicator, illustrated, establishes a high level of measurement accuracy. All instrument errors are said to be fully compensated for.

Y Diaphragm Control Valves. The Hammel-Dahl Co. announces a completely new line of Venturiflo Diaphragm Control Valves. The primary design incorporates a venturi throat which, it is said, insures the optimum in streamline flow characteristics. These valves are designed primarily for high pressure applications such as high pressure gas and oil well separators, high pressure gas transmission problems,



high pressure steam reduction, high pressure and high temperature petroleum cracking still operation under severe coking conditions, high pressure and high temperature synthesis of gaseous compounds. This type valves can be used to handle many difficult applications on the current fluid catalytic crackers, as well as many operations on the synthesis of oil from gas on current Fischer-Tropsch process plants.





875-psi, 900-F C-E boiler designed for 525,000 lb per hr has carried 640,000 lb per hr, yet COPES Flowmatic holds water level within plus-or-minus ½ inch. Write for Report 469 discussing Flowmatic control in three plants of this well-known Southern utility system.

Make boilers safer . . .

No matter how severe your loads, how sensitive your boilers, two-element COPES Flowmatic will give you the dependably close water level control that means safe, efficient operation. Protection against tube failure from low water and carry-over caused by high water is proved by charts like that above, and by more than 2000 installations at pressures up to 1825 psi. Adaptable to any piping layout. For specific recommendations, write in detail about your operating conditions.

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Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters

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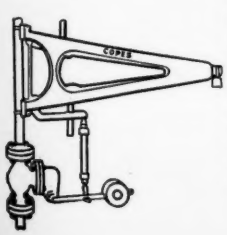
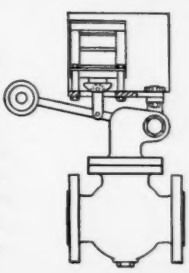


FOR SMALL BOILERS

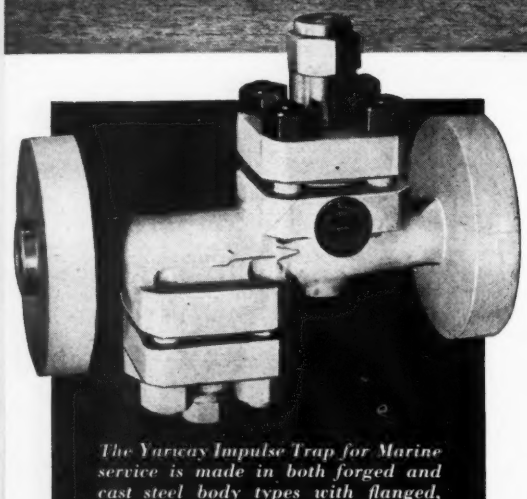
If you have smaller boilers which carry reasonably constant loads at moderate pressures, you can get all the benefits of continuous feed and stabilized water level from COPES Type OT—a simple level control feed water regulator. Compact, it is easy to install and maintain. A proved performer in hundreds of plants. Write for information.

SOLENOID VALVES

There must be a good reason why important plants have gladly paid a premium for COPES Solenoid Valves. It lies in the sound engineering design, plus the rugged construction which stands up under use and abuse. Not carried in stock, each valve is built for the individual installation. Sizes: ¾ to 6 inch. Write for data.



They Help Keep Tankers on the Move



The Yarway Impulse Trap for Marine service is made in both forged and cast steel body types with flanged, screwed or socket welding ends and with or without integral strainers. Shown at upper right — the standard Yarway Impulse Trap. Above: the Yarway Integral Strainer Trap.

ENTIRE fleets of Tankers are Yarway Impulse Trap-equipped because they make it possible to "discharge oil cargoes hours earlier" through their quicker heating and greater sustained heating efficiency.

Then, too, the Yarway Impulse Trap is a "natural" for Marine service. Its operation is entirely unaffected by the rolling and pitching of the ship. Its trouble-free design (*only one moving part—a simple valve*) insures great dependability and minimizes maintenance. *No buckets, bellows, floats or diaphragms.* It is *small in size to fit compactly into restricted spaces.* Its straight-through piping *simplifies installation. No change of valve or seat—for varying pressures.*

Throughout industry, wherever steam is used, the advantages of Yarway Impulse Traps are convincingly demonstrated. *Over 525,000 already purchased.*

See your Mill Supply dealer or write for Bulletin T-1739.

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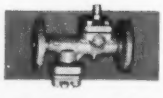
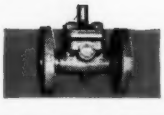
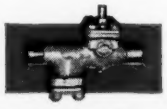


(Figure No. 140 to 147) Integral Strainer Impulse Trap for pressures up to 600 lb. Steel body, flanged connections.



(Figure No. 90 to 97) Impulse Trap for pressures up to 600 lb. (Using separate strainer.) Steel body, flanged connections.



(Figure No. 250 to 257) Integral Strainer Impulse Trap for pressures up to 600 lb. Steel body, socket weld connections.

(Figure No. 410 to 417) Integral Strainer Impulse Trap for pressures up to 150 lb. Bronze body, screwed connections.

YARWAY IMPULSE STEAM TRAP

The Future Need for Engineers

By THE ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

THERE HAS been much speculation as to the continued growth of demand for engineers, the ability of the engineering colleges to meet this demand, and the salaries which engineers can expect to obtain. Several studies covering engineering manpower have been made in the last few years, notably "The Outlook in the Demands for and Supply of Engineering Graduates," conducted by a commitee of the ASEE and reported in *The Journal of Engineering Education*, September 1946; and "Employer Practice Regarding Engineering Graduates," conducted by the Engineers Joint Council and reported in the April 1947 issues of *Mechanical Engineering* and *Electrical Engineering*.

Both surveys were conducted during 1946, the EJC questionnaire replies dating to August 1. However, the two reports differ in their conclusions.

The ASEE report points out the increasing employment of engineers by government agencies, the army, and the navy, and estimates that the increase in industrial employment of engineers from 1938 to the present time is 56 per cent. Industrial figures are based upon replies to 125 questionnaires and an independent "opinion poll." The increase of research and development engineers has been 2¼ times that of engineers in production, management, and sales. Not only are the companies increasing the ratio of research engineers to total engineers, but also, in the research field, they indicate a need for a higher percentage of engineers holding advanced degrees, while the opposite is true in production, sales, and management.

The ASEE report estimates that future annual need for new engineers will be 17 per cent of current employment. The ASEE also made an estimate of the total demand for engineers based upon data of the Bureau of Labor Statistics of the U. S. Labor Department. According to this, 90,000 students must be graduated between 1946 and 1950 to meet the Bureau's estimate of the accumulated need by 1950. On this basis, in 1950 about 46 per cent of all engineers will have entered the profession within the 10-year period 1940-1950, and about 27 per cent during 1946-1950. This situation offers a special challenge and opportunity to ECPD and its constituent engineering societies, particularly to ECPD's Committees on Engineering Training and Professional Recognition. With such a large percentage of neophytes in the engineering profession, well-coordinated programs of counseling, guidance, and indoctrination will be essential for the best interests of all concerned.

The EJC report is based upon a survey of a representative group of 104 industrial employers in 19 fields of industry, and indicates that over the next four years an average annual increase of about 8 per cent of the number of engineers employed by these companies is to be anticipated.

On the basis of certain estimates made by the ASEE committee, the deficit of engineering graduates will have been wiped out by 1952. The need for continuing engineering education at an over-load level therefore will lessen, beginning with the entering freshman class in 1949. However, future developments as yet unknown may have a marked effect on both the supply and the demand for technical personnel.

As an indication of the income of engineers, data secured between 1924 and 1930 by ASEE, ASCE, and ASME showed starting salaries ranging from $1,200, to $2,000, and averaging about $3,500 at 10 years after graduation. The EJC reports that beginning salaries in 1947 ranged from $1,800 to over $3,000, with the median at approximately $2,484; the median at the end of two years employment about $3,100. The ASEE report states that the average 1947 starting salaries for engineers with a B.S. is $2,520; with M.S.-$2,880; and with D.Sc.-$3,600.

Both of these reports dealt only with engineering employment in the United States. Canada, a nation whose geographical proximity alone gives her much in common with United States, has experienced a similar development of the engineering profession, although on a smaller scale. In 1941 Canada had 20,501 engineers (including those in military service at the time) a 14-fold increase since 1881. By January 1946 this figure had increased to 21,637, of whom the greatest number were in civil engineering. In 1946 there were 1,059 graduates from the 11 Canadian universities that confer engineering degrees, and by that year The Engineering Institute of Canada had acquired more than 8,000 members. The EIC is a participating member of ECPD, and the instrument for ECPD's services to Canadian engineers.

Loans and trade agreements with foreign governments may open up thousands of good engineering positions in areas now relatively undeveloped. On the other hand, more stringent national labor laws promoting self-sufficiency and various other barriers to investment and trade may develop, so that these opportunities will be postponed or lost.

The above comments are from the booklet "ECPD—A Challenge," issued in June, 1947, by the Engineers' Council for Professional Development as an audit of accomplishments and a rededication of plans for future action. It summarizes, therefore, the thinking of the leaders of the engineering profession on some of the important problems of the field. The Engineers' Council for Professional Development is a conference body organized to enhance the professional status of the engineer through the co-operative support of those national organizations representing the professional, technical, educational and legislative phases of an engineers life. The participating organizations are ASCE, AIM&ME, ASME, AIEE, EIC, ASEE, AICE and National Council of State Boards of Engineering Examiners. Chairman of ECPD for 1946-47 is James W. Parker, president, The Detroit Edison Co.

The complete report explains in detail the purposes and make-up of ECPD, which now represents well over 100,000 individual engineers. The report shows what has been done in accrediting engineering curricula in the colleges and in improving student selection and guidance. It outlines the organization's plans for specific future action on questions of professional training and recognition. Those interested may secure complete copies from the Council at 29 West 39th Street, New York 18, New York.

Half Million Volt Test Transmission Line Energized

For almost two years there has been under construction a high voltage test transmission line for research in the development of transmission lines as high as 500,000 volts. This program is sponsored by the American Gas and Electric Service Corporation in cooperation with a number of electrical equipment manufacturers who are contributing the actual equipment. Actually, there are three lines, two 1½ miles long and the other a single span in length. These lines were officially energized on October 1. These lines will provide opportunity of studying corona problems

RECOGNIZING the need for additional information concerning transmission voltages considerably higher than are now used in this country, the American Gas and Electric Service Corporation invited a number of manufacturers to cooperate with them in a research and test program. The Westinghouse Electric Corporation has contributed the power transformers, lightning arresters, and measuring equipment, and has also been active in planning the investigation. The American Bridge Company has contributed the towers, and the Ohio Brass Company and Locks Insulator Corporation, insulators and hardware. The Aluminum Company of America, General Cable Corporation, and Anaconda Wire & Cable Company have supplied the conductors, and the General Electric Company is supplying an oil circuit breaker and arrester. Also participating in the project are The Ohio Power Company, Appalachian Electric Power Company, Indiana & Michigan Electric Company, Wheeling Electric Company, Kentucky and West Virginia Power Company, Incorporated, and Kingsport Utilities, Incorporated, all subsidiaries of the American Gas and Electric Company. To carry on this program a field site was chosen at Brilliant, Ohio.

Of primary importance in considering transmission at voltages in excess of 230,000 are power transmission ability, reliability, and economics. Transmission ability, or power limit, is increased roughly as the square of the voltage — hence, the urge to higher voltages. Power limit also varies inversely as the impedance. A small spacing between conductors is thus desirable to reduce impedance and increase transmission ability. Economy is also promoted when the spacing between conductors is as low as possible so that towers can be made lighter and smaller.

One of the most important factors affecting reliability is the degree of protection against lightning outages. Beyond a certain number of insulators, which in turn fixes the air gap clearances to the tower and the spacing between conductors, a line becomes essentially lightning proof. Thus beyond a particular line voltage, lightning protection is independent of the transmission voltage utilized. This limitation for the types of construction normally employed in this country is reached at about 16 to 18 insulator units with flat configuration of the conductors, and with tower footing resistance below 20 ohms.

Power transmission ability is increased, and costs are reduced by utilizing a small conductor spacing. On the other hand corona losses are higher with closer spacing of conductors. Thus, corona is important because the power loss associated with it may constitute an important economic factor and because excessive corona may interfere with radio reception in the vicinity of the line.

High Voltage Corona to Be Studied

A definite lack of information exists regarding certain phases of the corona problem. Transmission at extra high voltages will probably involve larger conductor sizes and different arrangements, upon which very limited data are now available. Previous corona tests were limited in the conductor spacings that were used, and were made mostly without ground wires in position. Little or no data are available on the effect of towers, particularly with regard to radio influence. Previous investigators have concentrated on such phases of the problem as the surface conditions of the conductor — the effect of die grease, pulling burrs, weathering, etc. — and upon atmospheric conditions—temperature, barometric pressure, and humidity. However, rain, hail, sleet, and snow and even cloudy weather exert a profound influence upon corona effects and on these features further data are essential.

Thus it is clear that existing data are too indefinite to project higher voltage transmission lines with engineering certainty, without further study and research into the corona and associated problems. For this reason the test project described was initiated.

Full Scale Equipment to Be Used

A flat relatively level area was chosen for the test project along the banks of the Ohio River just outside of the Tidd Power Plant at Brilliant, Ohio, 48 miles by road from Pittsburgh. Three test lines such as would be used on an actual system are provided; two of them are 1½ miles long and the third is one span in length. The latter will be used primarily for preliminary tests on different diameter conductors and on combinations of "grouped" conductors, and for tests on leakage of insulator strings.

Transformers

A bank of three single-phase transformers converts the energy from the 66-kv 3-phase supply to a high tension voltage, line to line, ranging from 264,500 v to 500,000 v. The transformers have a bank rating of 5000 kva. Some idea of their size can be obtained from the fact that the distance from the bottom of the tank to the top of the bushing measures 33 feet. The transformers are connected delta on the primary side and solidly grounded wye on the secondary or high-voltage side.

Busses

Busses are provided for connection of the three transmission lines to the transformers. A special bus structure was constructed which covers an area approximately 340 ft by 220 ft. The distance of the upper conductors from the ground is 54 ft. Ground wires extend over the transmission line and station and completely shield the bus structure. The bus itself is of two-inch segmental copper conductor to minimize corona on the bus even at high voltage, and to provide means for shielding the measuring leads

which are carried inside the bus conductor. In this manner any loss associated with the bus structure is excluded from the measuring circuit. The bus is supported by 26 insulators per string.

Towers

Each 1½ mile line consists of seven towers, of which two are dead-end towers. The ground wires are 124 feet above ground at the towers and the height can be varied within limits. Provision has been made to vary the lateral spacing of the conductors between 32 and 45 ft. The height of the conductors at the towers is about 85 ft and they are sagged 45 ft. Average span length is approximately 1100 ft.

Insulators and Hardware

The lines are strung with 30 conventional 5¾ in. spaced insulators per suspension string. Provision will be made for determining the effect of shorter strings. Different types of grading rings are provided by the insulator manufacturers and in all cases are connected to the line end of the string only. Special hardware for each particular type of conductor is provided.

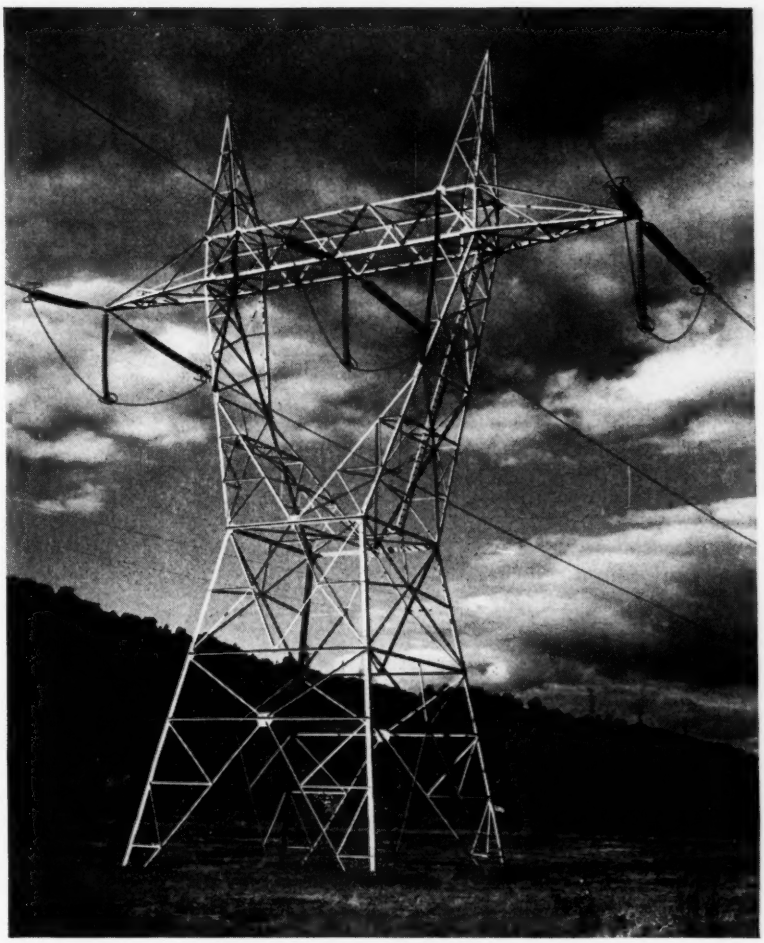
Line Conductors

The line conductors now installed are 1.65 in. OD segmental copper conductors on one line; 2.0 in. OD ACSR with paper filled on the second line; and 1.65 in. OD stranded copper with I-beam core on the short line. It is planned to use a smaller single conductor segmental copper, and the "bundle" or grouped conductor later in the tests on the short line.

Lightning Arresters

Two types of lightning arresters are provided to protect the transformers and to obtain service experience at these high voltages. Since the line will operate at 500 kv at times, arresters with a maximum rating of 350 kv have been provided. This represents a 70 per cent arrester which is justified because the system is well grounded. Electrically, the arresters are made up of standard units which will withstand the conventional impulse tests. For operation of the line at sustained voltages for a long period of time, provision is made to short circuit certain sections of the arrester so that operating experience can be obtained on a proportional part of the arrester.

Mechanically, the construction departs quite radically from past tradition. Two types of units have been provided, one is self-supporting in the form of three columns of elements in which each column consists of alternate sections of insulators and arrester units. The other type of arrester is suspended from the bus structure so as to provide an earthquake-proof construction, thus enabling experience to be obtained on an arrester that might be required in earthquake areas. Grading rings are placed to distribute the potential uniformly between the individual units comprising the complete arrester. The height of the self-supporting arrester is 29 ft and of the suspended type 23 ft. These are the largest arresters that have ever been built.



Dead end tower for 500 kv test line

Measuring Equipment to Be Read with Telescope

The instruments for measuring corona loss are mounted in an aluminum box located on top of the transformer high voltage bushings. Potential for the instruments will be provided by an extension of the main winding of the transformer at the high voltage end. This extension not only supplies power to the volt-meter and potential coils of the instruments, but also power for auxiliary equipment such as lights, rectifiers, controls, etc. The corona loss is measured directly by wattmeters with current coils in series with the line. Power is measured by indicating instruments observed through a high-power telescope from an observation booth located approximately 60 ft away, or can be recorded over long periods of time by means of graphic meters. Special high speed recording meters are provided which can be controlled remotely as desired. The slowly moving meters permit integrating effects over long periods of time and the high speed meters permit study and coordination of loss under abnormal weather conditions. Remote control of the measuring equipment is provided by supervisory control relays operated from the observation booth. Locating the metering equipment on top of the transformer bushings has the advantage of eliminating the losses in the transformer itself. Various other measuring instruments to record atmospheric conditions will be provided, such as a graphic thermometer, barometer, hygrometer, precipitation meter, and an instrument for measuring of ground gradients which may influence corona.

An important phase of these tests is the determination of radio influence. Modern instruments for measuring these effects will be provided. A portable instrument that will permit measurements along the line and at various points laterally from it will be used. Radio frequency traps have been installed in each line to

(Text continued on page 76)

Views of 500 K

On these two pages are shown views of the half million test transmission line constructed at Brilliant, Ohio. The equipment used on this test line was contributed by a number of manufacturers of electrical equipment. The line was officially energized Oct. 1

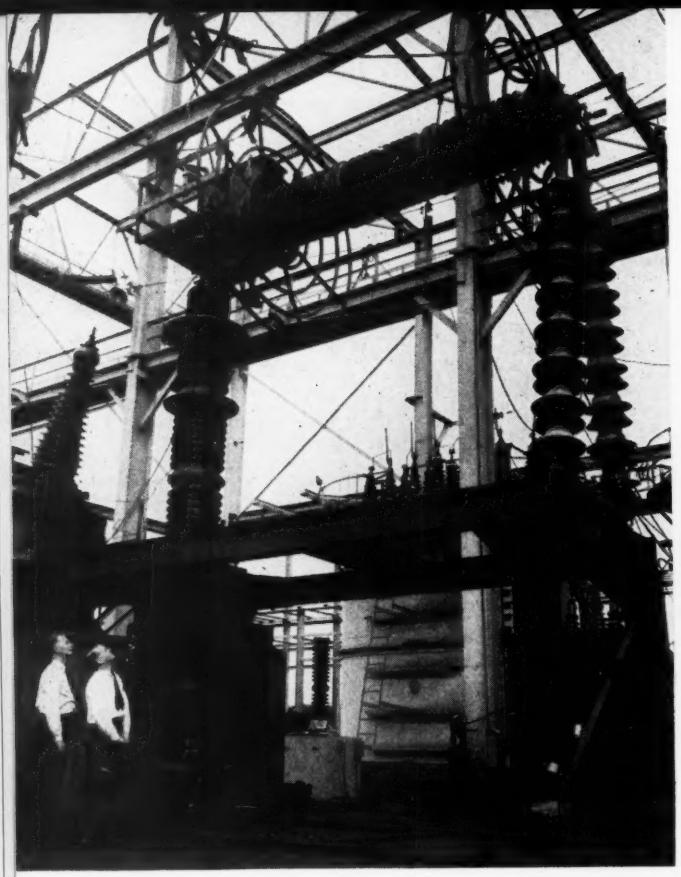


Fig. 1. (Above) General Electric engineers inspecting a single pole power circuit breaker element constituting one of the major components of a switching unit in the 500 kv test line. (Photo, G.E.)

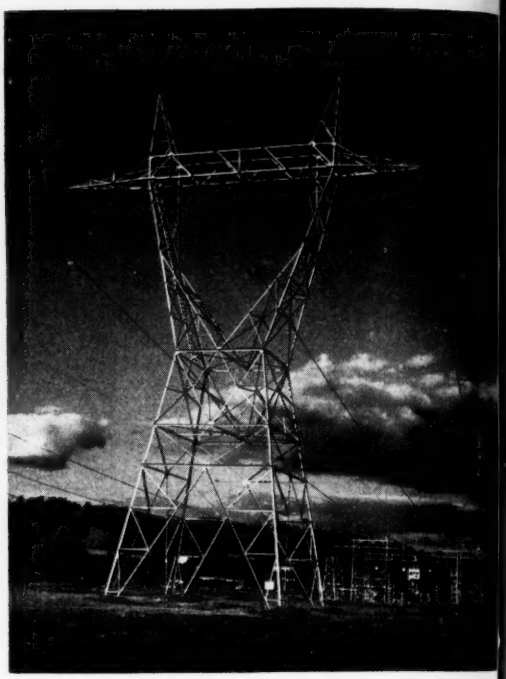


Fig. 2. (Right) Tangent tower for the 500 kv test line. Single circuit, flat configuration, to operate initially without ground wires, using 30 insulators per suspension string. (Photo, Ohio Brass Co.)

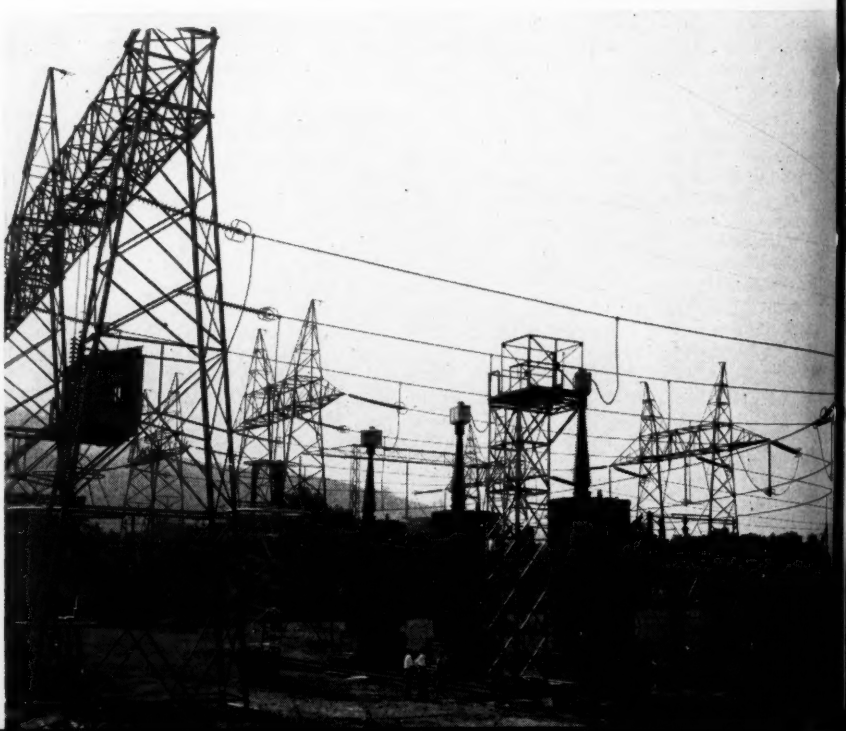


Fig. 3. (Right) Station end of the line showing observation booth, lightning arresters, transformers, and low-voltage circuit breaker. The bank of three single-phase transformers in the middle foreground converts the energy from the 66 kv, 3-phase supply to a high tension voltage, line to line, ranging from 264,500 to 500,000 v. (Photo, Westinghouse)

XUM

Test Line at Brilliant, Ohio

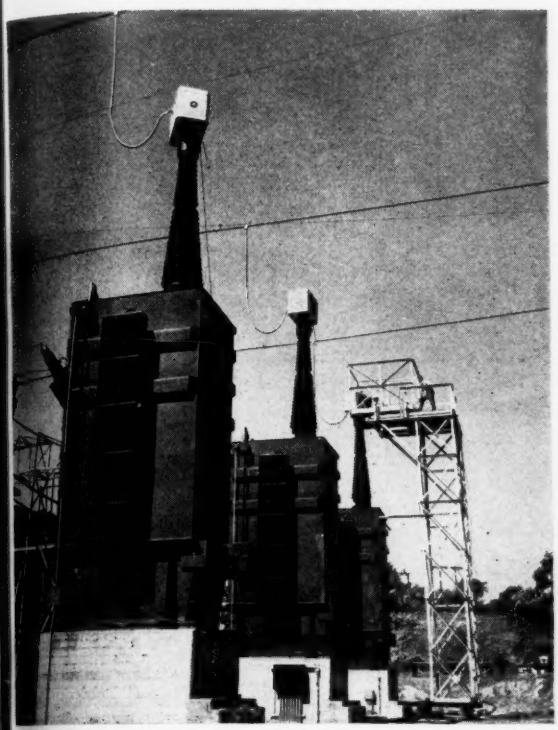


Fig. 4. (Above) A close-up view of the three single phase transformers. A movable steel platform is used to service metering equipment. (Photo, Westinghouse)

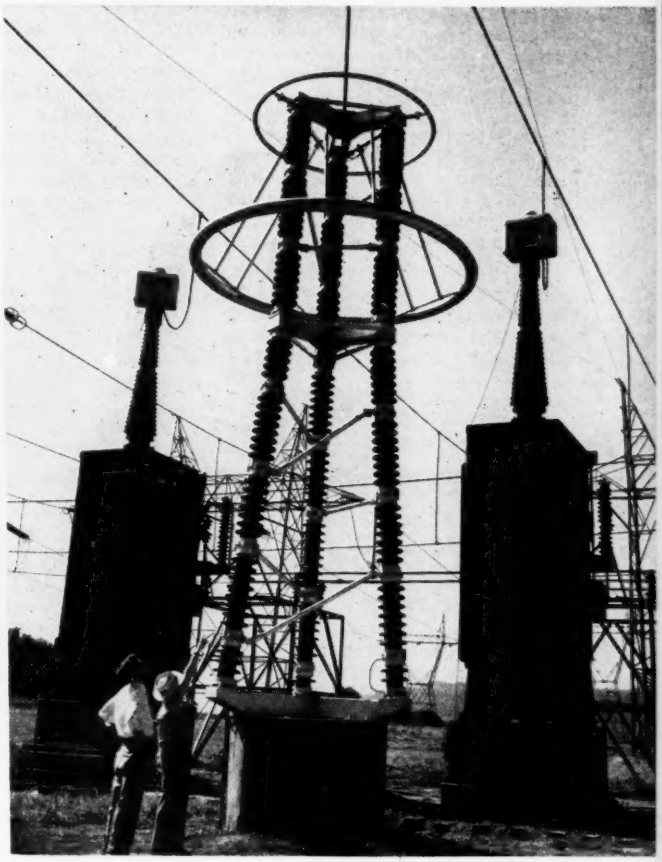


Fig. 6. (Above) The world's largest self-supporting lightning arrester at the Brilliant, Ohio, test line

Fig. 5. (Below) Westinghouse 500 kv earthquake proof lightning arrester

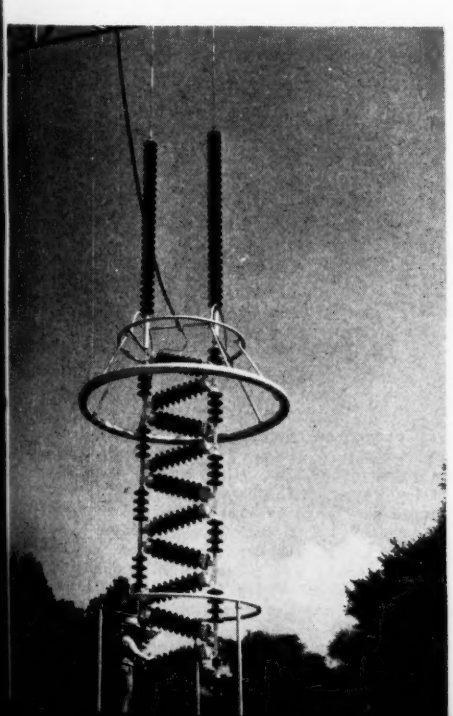
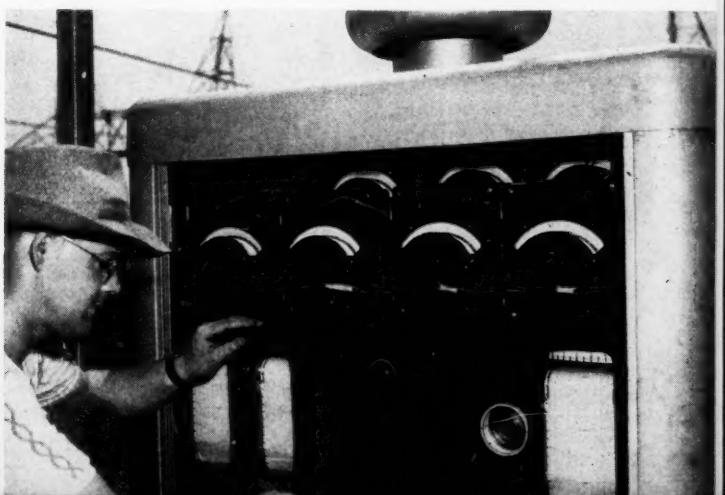


Fig. 7. (Below) Westinghouse corona measuring equipment mounted 35 ft above ground on the transformer bushing. These units can be seen in Figs. 3 and 6



(Text continued from page 73)

confine disturbances that might originate within the substation area and prevent their being propagated into the line on which measurements are being made. A second instrument will be used to record radio noise over long periods of time at particular points along the line.

Mechanical and Electrical Factors to Be Tested

The features toward which attention will be directed initially in this field research on corona and other phenomena are:

1. ***Conductor sizes*** ranging in diameter up to two inches in both the segmental and wire form will be tested. Grouped conductors consisting of 2, 3, and 4 wires, smaller in diameter than if only one per phase were used, and spaced at distances in the order of one or two feet, will also be tested.

2. ***The number of insulators*** will be varied up to a maximum of 30.

3. ***Lateral spacing*** of conductors in flat configuration will be changed.

4. ***The height of the ground wires*** will be varied in several steps and the effect of the presence and absence of ground wires determined under identical weather conditions.

5. ***Conductor weathering*** will be studied.

6. ***Atmospheric conditions*** such as rain, fog, sleet, hail, and snow will be investigated. Interpretation of results will be facilitated by recording the loss over long periods of time.

7. ***Atmospheric electrical gradients*** at the ground and their variation with rain clouds and also their influence upon corona will be studied.

8. ***Insulator loss*** as affected by fog, sleet, and rain will be susceptible to determination.

9. The effects of all these factors on radio reception will be determined. In particular, the conditions at the tower will be given careful attention.

Technical Description of This Field Research Project

A more complete description of this cooperative test research, including objectives, details of layout, apparatus, metering equipment, etc., will be covered by a group of seven technical papers to be presented before the American Institute of Electrical Engineers at its midwest meeting in Chicago, November 3 to 7, 1947.

Electronic Timer for Viscosity Measurements

A NEW ELECTRIC TIMER, particularly adapted for use with a falling-ball viscosimeter in the study of the rapidly changing viscosity of an opaque fluid, has been designed by P. J. Franklin of the National Bureau of Standards. The device consists of pulse sharpening and trigger circuits, and the passage of the ball through two coils around the viscosimeter tube is used to trigger a radio frequency oscillator, starting and stopping a timing device.

In measuring viscosity by the falling-ball method, a closed tube, surrounded by a constant-temperature jacket and containing a ball immersed in the liquid to be studied, is quickly inverted. Viscosity is determined from the rate of descent of the ball through the liquid, and this requires accurate timing, which the electronic timer provides. The method is very

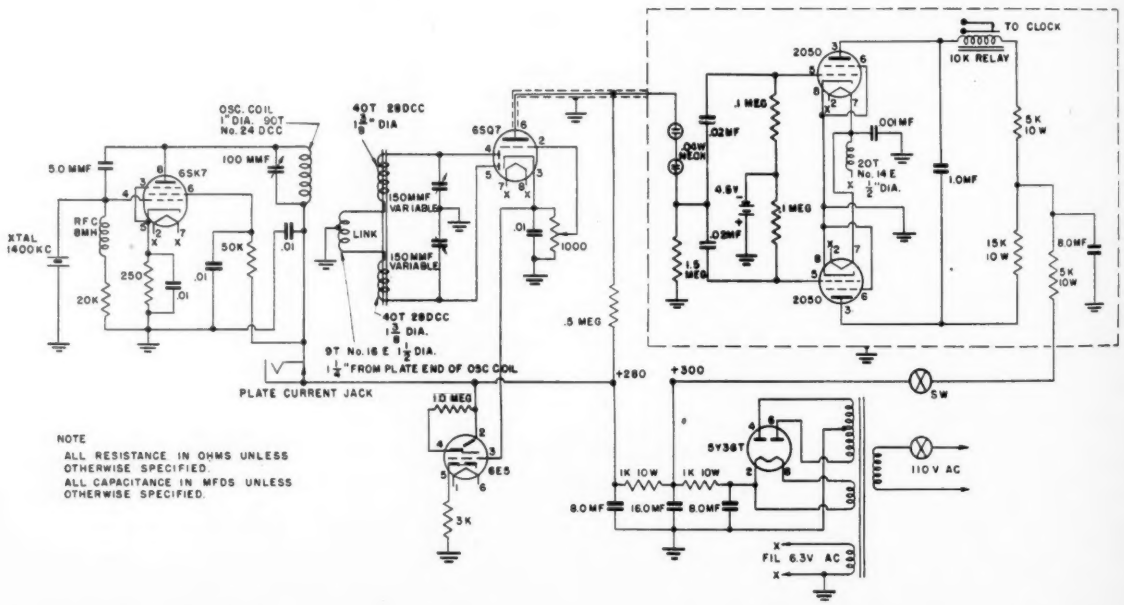


Fig. 1. Circuit diagram for the new electronic timer for viscosity measurements developed at the National Bureau of Standards. This circuit was especially designed for the determination of the rapidly changing viscosity of an opaque material with a falling-ball viscosimeter, in which a ball is allowed to fall through the liquid under investigation. The device consists of a 1400-kilocycle crystal oscillator, a tuned diode detector, a pulse sharpening circuit, and a trigger pair, all operated on a common power supply. The output of the oscillator is fed into two coils surrounding the viscosimeter tube. As a steel ball falls through the viscosimeter tube the inductance of each coil in turn is affected. The power from each coil is rectified in the diodes of the 6SQ7 tube, and the resulting variation in cathode current is amplified in the triode part of the tube. Sufficient voltage variation is thus obtained to operate a pulse sharpening circuit, consisting of two neon bulbs in series with a load resistor. When the plate voltage of the amplifier reaches the ignition point of the neon tubes, a sharp pulse occurs across the load resistor. The pulses from both coils are placed on the grids of the trigger pair, which on the first pulse starts a clock and on the second pulse stops the clock, thus providing an automatic record of time of fall

Fig. 2. Photograph illustrating the timing of a falling-ball viscosimeter by means of the new electronic timer (at right) developed at the National Bureau of Standards. The output of a crystal oscillator is link-coupled to the two coils encircling the tube of the viscosimeter (within the constant-temperature jacket adjacent to the time). The inductance of the coils is changed as a steel ball falls down the tube through liquid whose viscosity is to be measured. The resultant change in power from each coil, upon subsequent amplification, offers sufficient voltage variation to operate a pulse-sharpening circuit, consisting of two neon bulbs in series with a load resistor. The two short pulses produced are applied to a trigger pair, which on the first pulse starts the clock and on the second pulse stops the clock, thus automatically recording time of fall

useful for viscosity measurements in many industries—for example, in the production of paints and lacquers where the instrument must be enclosed to prevent evaporation of volatile solvents. The falling-ball viscosimeter is also used in the oil and asphalt industries. Here the opacity of the liquids involved makes nonvisual timing a necessity. For similar reasons, viscosity measurements of catsups, jams, jellies, and other foods are perhaps most efficiently carried out with a falling-ball apparatus equipped for electronic timing.

A comparatively simple circuit was developed for the timer, making use of the radio frequency induction field. The output of a 1400-kilocycle crystal oscillator is link-coupled to the start and stop coils surrounding the viscosimeter tube. No buffer amplifier is required. A small padding condenser is placed across each coil, so that the amount of detuning is the same in both coils as a steel ball falls through them, changing the inductance of each coil in turn.

The radio frequency power from each coil is rectified in the separate diodes of a 6SQ7 tube, and the resulting change in cathode current is amplified in the triode portion of the tube to obtain sufficient voltage variation to operate a pulse sharpening circuit consisting of two 0.04-watt neon bulbs in series with a load resistor. When the voltage in the plate circuit of the amplifier rises to the ignition point of the neon tubes, the neons suddenly fire and a sharp pulse is produced across the load resistor. These tubes have a small amount of radium added to provide uniform ignition voltage regardless of illumination. Furthermore, they have the advantage that once ignited they stay ignited until the output with the passage of the ball through each coil. Both pulses are placed on the grids of a trigger pair which on the first pulse closes a relay that starts a clock and on the second pulse opens the relay to stop the clock. Time of fall, as measured with this circuit for one direction of travel, was found to be reproducible within 0.01 second for a fall time of 2.5 seconds.

The electronic timer was designed for a process requiring repeated measurement of the viscosity of an opaque liquid held within a limited temperature range. Several standard methods of determining viscosity are used in the laboratory. Most of these may be grouped into those based upon rate of flow through a capillary tube or through a small orifice and those depending upon the rate of rotation of a cylinder or paddle wheels within a cup containing the liquid. Use of capillary tubes was considered impractical for measuring the viscosity of the opaque liquid, since the tubes would need continual refilling and would also be very difficult to clean after the material had set. If rate of flow through an orifice had been used, holes of increasing size would have been required as the liquid became more viscous. In the paddle wheel or cylinder methods, handling or cleaning would have been inconvenient after the material had thickened. Nor were any of these procedures well adapted to temperature control. It was therefore decided that the falling-ball apparatus was most suitable for this application. The opacity of the material being studied, however, precluded the use of visual timing.

While various electrical methods employing the conductive or magnetic characteristics of the falling ball had previously been used to measure its time of travel, none of these methods was considered completely satisfactory, due to lack of sensitivity, poor reproducibility of results, or the complicated nature of the circuit required. The induction method used in the timer proved to be the answer to the problem.

TRANSFORMER MAINTENANCE HINTS

TRANSFORMERS require less care and attention than almost any other kind of electrical power apparatus. This, however, is not a reason for neglecting them. The conditions under which they operate will determine to some extent the frequency with which they should be inspected.

The oil should be tested for dielectric strength and the presence of sludge. If there is an indication of moisture or sludge formation, the oil should be tested further and treated as described later, or in the manufacturer's instruction book. If tests show the oil to be in bad condition, an inspection should be made on the inside of the tank for possible cause of the trouble. However, if the oil tests satisfactorily the case should not be opened but a careful inspection of all accessories should be made to see that they are functioning properly.

Any symptoms such as unusual noises, high or low oil levels, rupturing of relief diaphragm, etc., should be investigated at once.

Any increase in operating temperature at normal load should be investigated and if the cause cannot be determined the transformer should be taken out of service and given a thorough inspection.

Transformers which have been subjected to unusually severe operating conditions such as overloads, or frequent short circuits, and special units such as furnace transformers should be inspected internally at least once a year. This can usually be done adequately by lowering the oil level and inspecting with a light through the manhole.—Westinghouse Maintenance Hints.

Sampling Coal for Analyzing Purposes

Coal purchased on analyses basis requires fair sampling . . . Correctness of analysis depends upon accurate sampling . . . Collection of gross samples . . . Reduction of gross sample to laboratory size . . . Precautions to be taken in delivering the sample

ENGINEERS who have the problem of buying coal in large quantities for industrial purposes have long been aware of the significance of such factors as moisture, slate, ash, sulfur content, heating value, and the fusion point of the ash which form the basis for coal evaluation. When purchases of coal are made on specifications, which is quite common practice in industry today, samples are taken from deliveries and tested and reports of tests carefully scanned to detect any deviation from the specifications in order to accept or reject shipments, levy penalties, or in some cases to determine premium payments if the coal exceeds specified requirements.

In spite of all precautions taken in the analysis of coals, there are misleading and unfair conditions that work injustice either to the vender or to the consumer due to the fact that the method used in sampling the delivery was unfair. That is, that the sample was not a true sample of the entire quantity of coal represented by the sample.

This oversight has been observed not only among the small consumers but large consumers as well, and in laboratory practice it is readily apparent that any analysis of a non-representative sample of any material is worse than useless. Coal is no exception to this fundamental rule and the fact that it is one of the most difficult materials to sample properly is undoubtedly the reason why so many inaccurate samples reach the laboratory. Homogeneous materials present few sampling problems, coal, however, is decidedly not in this category.

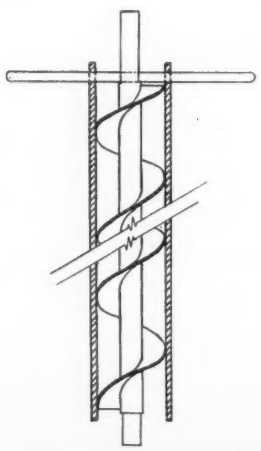


Fig. 1. Probe for collecting coal samples

Table I. Commercial sampling procedure for coals classed according to ash content

Top Size Range	Group 1 ⅝ in. or less	Group 2 ⅝ to 1¼ in.	Group 3 1¼ to 2 in.	Group 4 2 to 6 in.	Group 5 2 to 4 in.	Group 6 4 to 6 in.
			Less than 8 per cent Ash			
Minimum number of increments	15	15	15	15	15	15
Minimum weight of increment, lb	2	4	6	10	10	15
Minimum weight of gross sample, lb	30	60	90	150	150	225
			8.0 to 9.9 per cent Ash			
Minimum number of increments	20	20	20	20	20	20
Minimum weight of increment, lb	2	4	6	10	10	15
Minimum weight of gross sample, lb	40	80	120	200	200	300
			10.0 to 14.9 per cent Ash			
Minimum number of increments	35	35	35	35	35	35
Minimum weight of increment, lb	2	4	6	10	10	15
Minimum weight of gross sample, lb	70	140	210	350	350	525
			15.0 per cent Ash and over			
Minimum number of increments	35	35	35	35	35	35
Minimum weight of increment, lb	2	4	6	10	10	15
Minimum weight of gross sample, lb	70	140	210	350	350	525

Size of Samples

As it is delivered to the plant, coal contains from 8 to 40 per cent of inert matter or impurities such as moisture, slate, bone and pyrites. So to get the same proportion of coal and these inerts in the sample as exists in the delivery represents quite a difficult problem. It is obvious that if a small sample of about 5 to 10 lb is taken to represent a shipment of 500 tons the chance inclusion or exclusion of too much inert matter will greatly affect the sample and render it decidedly unrepresentative. If 100 lb were taken instead of 5 or 10 the bad effect of chance selection is lessened, therefore it becomes apparent the larger the gross amount or gross sample, as it is termed, that is taken the more representative the sample is likely to be.

The standard method of coal sampling is based on the principle of ratio of particle size to mass of sample. This method consists essentially of: (a) selecting a gross sample of sufficient size to render chance inclusion or exclusion of impurities a negligible factor; and, (b) by successive operations reducing particle size by crushing, and reducing the mass of the sample by a hand process called quartering, or mechanically by the use of riffles, to a laboratory size of about 7 lb that in turn is representative of the delivery. The mass of the gross sample is governed by the particle size of both coal and impurities and the amount of inerts in the coal.

Run-of-mine bituminous coal containing an average amount of im-

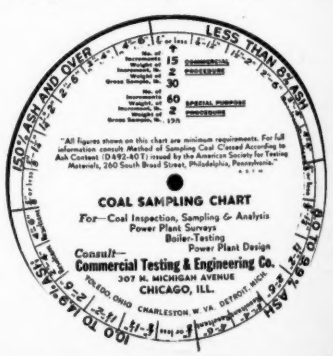


Fig. 2. Coal sampling chart designed to make data in Table I conveniently available

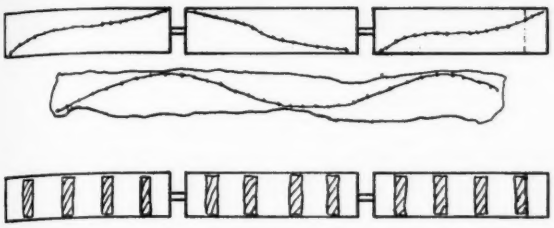


Fig. 3. Sampling points for carloads of coal and coal piles

Fig. 4. Trench method of sampling

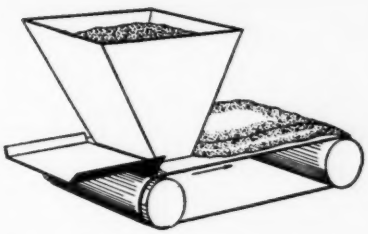


Fig. 5. Manually operated sampler for coal enroute to furnace

purities calls for a 1000 lb gross sample from a carload shipment of 50 tons. Slack or small size anthracite in which the impurities do not exist in abnormal quantity, or exceed ¾ in. in particle size requires only 500 lb in the gross sample. Coal containing an unusually large amount of impurities, however, or if such impurities are very large in size, will call for a gross sample of at least 1500 lb. In all cases a separate 100 lb sample is also taken and reduced rapidly to avoid loss of moisture to 5 lb, for the laboratory to use in determining the moisture content of the coal as received. The requirements indicated in Table I for lots up to 1000 tons are specified by the ASTM.

To collect a representative sample from wagon load, car load, or boat load lots of coal as well as coal piles care must be taken to choose shovelfuls or probe samples from different parts of the load or pile and which include an average amount of impurities.

Two distinct types of sampling methods have been devised for sampling coal at rest in cars, barges or piles. One of these is by means of a probe which consists of a 4 in. pipe into which an auger or screw conveyor element is fitted to prevent the loss of the sample when the probe is withdrawn. The probe is worked vertically down into the coal pile from top to bottom by means of a cross-bar handle in a manner similar to using an auger. When withdrawn the contents of the probe is emptied in a bucket as part of the gross sample. When used in a closely packed pile, a probe of this sort will cut a round hole through lumps and fines drawing out of the core without greatly disturbing the surrounding particles. The minimum size of the increments should be from 2 to 15 lb depending upon the size of the coal

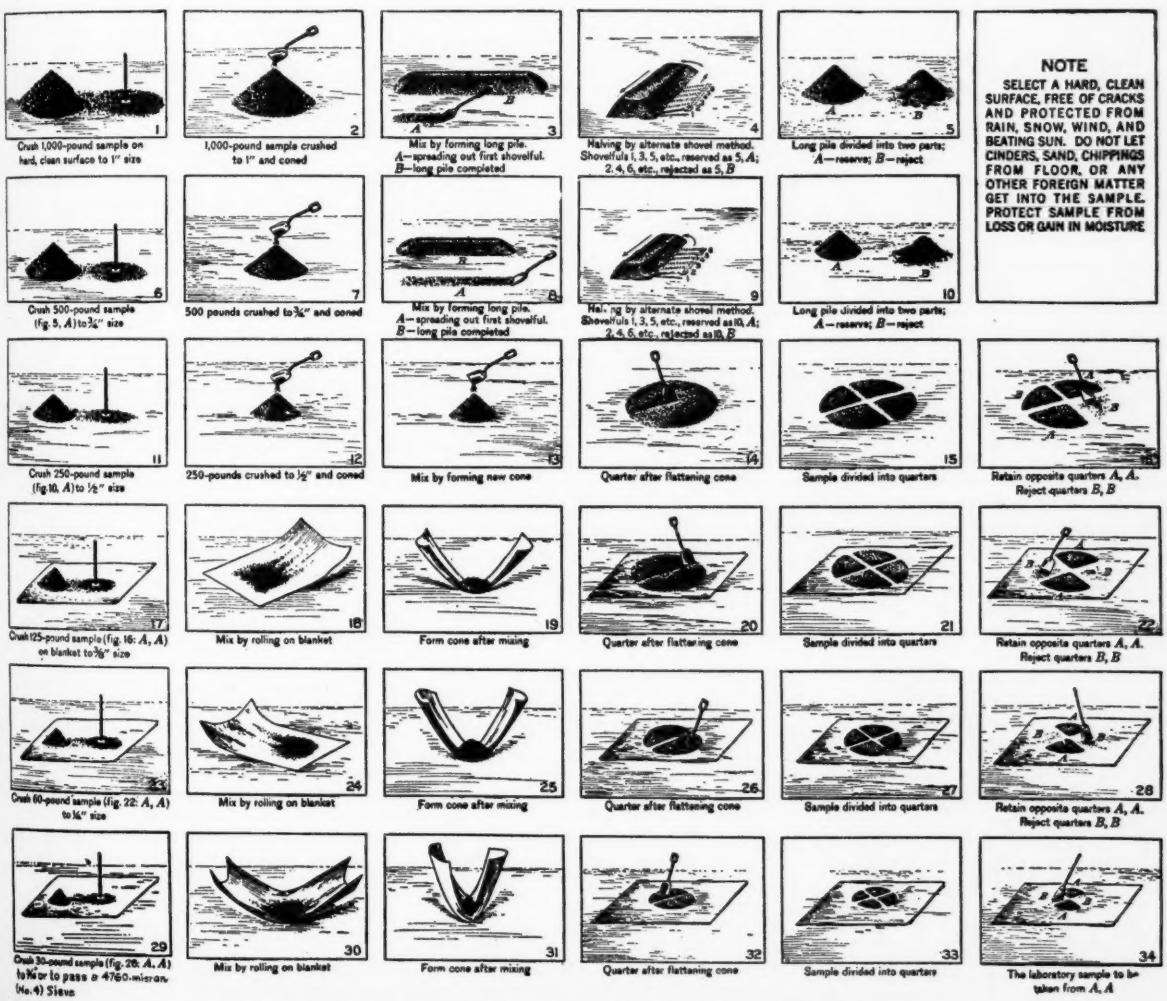

NOTE
SELECT A HARD, CLEAN SURFACE, FREE OF CRACKS AND PROTECTED FROM RAIN, SNOW, WIND, AND BEATING SUN. DO NOT LET CINDERS, SAND, CHIPPINGS FROM FLOOR, OR ANY OTHER FOREIGN MATTER GET INTO THE SAMPLE. PROTECT SAMPLE FROM LOSS OR GAIN IN MOISTURE
Crush 1,000-pound sample on hard, clean surface to 1" size
1,000-pound sample crushed to 1" and coned
Mix by forming long pile. A—spreading out first shovelful. B—long pile completed
Halving by alternate shovel method. Shovelfuls 1, 3, 5, etc., reserved as 5, A; 2, 4, 6, etc., rejected as 5, B
Long pile divided into two parts; A—reserve; B—reject
Crush 500-pound sample (fig. 5, A) to ¾" size
500 pounds crushed to ¾" and coned
Mix by forming long pile. A—spreading out first shovelful. B—long pile completed
Halving by alternate shovel method. Shovelfuls 1, 3, 5, etc., reserved as 10, A; 2, 4, 6, etc., rejected as 5, B
Long pile divided into two parts; A—reserve; B—reject
Crush 250-pound sample (fig. 10, A) to ½" size
250-pounds crushed to ½" and coned
Mix by forming new cone
Quarter after flattening cone
Sample divided into quarters
Retain opposite quarters A, A. Reject quarters B, B
Crush 125-pound sample (fig. 16: A, A) on blanket to ⅜" size
Mix by rolling on blanket
Form cone after mixing
Quarter after flattening cone
Sample divided into quarters
Retain opposite quarters A, A. Reject quarters B, B
Crush 60-pound sample (fig. 22: A, A) to ¼" size
Mix by rolling on blanket
Form cone after mixing
Quarter after flattening cone
Sample divided into quarters
Retain opposite quarters A, A. Reject quarters B, B
Crush 30-pound sample (fig. 28: A, A) to ⅛" or to pass a 4760-micron (No. 4) Sieve
Mix by rolling on blanket
Form cone after mixing
Quarter after flattening cone
Sample divided into quarters
The laboratory sample to be taken from A, A

Fig. 6. Hand method of preparing coal sample for analysis standardized by ASTM

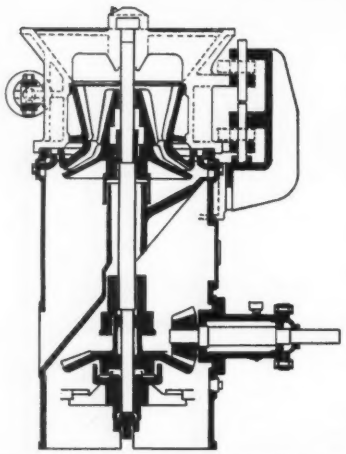


Fig. 7. Cross-section of mechanical coal crusher and sampler, made by Sturtevant Mill Co., which delivers 5, 10 or 15 per cent of gross sample of coal passed through the machine

and the ash content. Table I gives the recommendations of the ASTM in regard to the number of increments, size of increments and gross samples for various sizes and ash contents.

The points at which to probe the coal is a matter pretty largely of judgment on the part of the operator, for it depends greatly upon how the car or boat was loaded or the coal pile formed. It is obvious that the samples should be taken from well distributed points if a fair sample is to be obtained.

The other method is by trenching the load or coal pile. By this method several trenches are dug across the pile. The increments are then gathered from the sides and bottom of the trenches in such number as to represent proportionately each section of the pile to be tested.

Samples gathered at the mines are taken while the coal is in motion. A favorite method is to catch samples in a bucket swung at regular intervals across the stream of coal as it is being loaded into cars or boats from the belt conveyor of the loading boom.

When unloading coal at the power

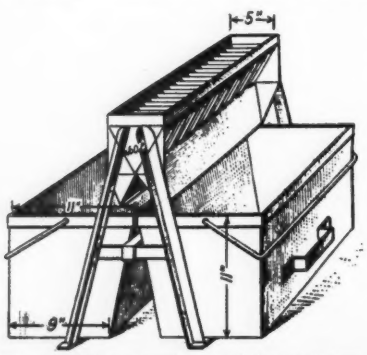


Fig. 8. Riffle sampler used for reducing size of sample. Adjacent cells discharge to opposite receptacles

plant by hand shoveling, about one out of every 100 shovelfuls, roughly 1 per cent, should be put aside for sample purpose. When unloading from drop-bottom cars a man can be stationed to gather the samples at regular intrevals as the coal discharges. Sampling coal being handled by clamshell or grab buckets is fairly done by setting aside regularly one load in 100 handled. Samples can readily be gathered at the discharge of any type of conveying system by collecting bucketfuls at regular intervals, the idea being to get a complete cross-section of the coal as it passes the sampling station.

Provision should be made for the preservation of the integrity of the sample, by placing it in clean, dry containers that will not permit it to become wet or contaminated with dust or other foreign materials. A gross sample could be taken for each 500 tons or fraction thereof, or in cases of larger tonnages for such quantities as may be agreed upon.

After the gross sample has been collected it is systematically crushed, mixed and reduced in quantity to

Table II. Sample weights and sizes of coal suitable for process of preparation

Weight of Sample to Be Divided, lb	Largest Size of Coal and Impurities Allowable in Sample Before Division, in.
1000 or over	1
500	¾
350	½
125	⅜
60	¼
30	3/16 or to pass a 4760-micron (No. 4) sieve

convenient size for transmission to the laboratory. Many modern commercial laboratories are equipped with reducing machinery and prefer gross samples to the laboratory samples prepared in the field. The sample may be crushed by hand or by any mechanical means but under such circumstances as will prevent loss of coal or the accidental mixture of foreign matter.

In the hand method, which is still widely used but no longer recommended by fuel specialists, samples of quantities indicated in Table II, which was prepared by ASTM, are crushed so that no pieces of coal and impurities will be greater in any dimension, as judged by eye, than specified for the sample. The method of reducing by hand the quantity of coal in a gross sample is carried out as prescribed in Fig. 6, even should the initial size of coal and impurities be less than indicated in Table II.

When mechanical preparation, now being recommended by ASTM, is employed, gross samples of coal containing pieces ⅜ in. and larger are crushed before dividing so that at least 95 per cent by weight will pass through a 4760-micron (No. 4) seive and all will pass through a ⅜ in. round-hole screen. The gross samples may be divided before crushing to not less than 60 lb by means of a riffle sampler or its equivalent.

For the determination of total moisture, the special moisture sample should weigh approximately 100 lb and should be accumulated by placing in a water-proof receptacle with a tight fitting and water-proof lid small equal parts of freshly taken increments of the standard gross sample. The accumulated moisture sample should be rapidly crushed and reduced mechanically or by hand to about a 5 lb quantity which should be immediately placed in the container and sealed airtight and forwarded to laboratory without delay.

The caution is made that only when equally representative results will be obtained should the standard gross sample be used instead of the special moisture sample for the determination of total moisture.

Laboratory samples which have been produced by the quartering method or mechanical means should not be less than 15 lb in quantity. The laboratory sample should be placed immediately in a suitable container and sealed in such a manner as to preclude tampering. All samples should be carefully labeled so that there can be no confusion in associating the analysis with the proper coal lot.

Obtaining a fairly representative sample of a delivery of coal is the first step in making an analysis and should be as carefully done as is the chemical laboratory process, for the final result cannot be any more accurate than the laboratory sample tested.

UNUSUAL TURBINES UNDER CONSTRUCTION

AMONG THE unprecedented number of new central-station turbines on which construction is now beginning at the Steam Division of Westinghouse are two of unusual engineering interest. One is a 65,000-kw triple cylinder machine for Boston Edison Co. The other is a 30,000-kw turbine for Dow Chemical Co.

On the Boston Edison unit, the steam conditions, while high, are not unusual, but the unit will employ steam reheating to an uncommon degree. Steam is to be supplied at 1450 psig and 1000 F. Steam enters the high-pressure turbine at 1450 psig and is exhausted at approximately 365 psig. The steam then returns to the reheat boiler and thence re-enters the intermediate-pressure element at 1000 F. The low-pressure turbine has an inlet pressure of approximately 40 psig and is of the conventional double-flow construction.

The 30,000-kw turbine for Dow Chemical Co. is designed to operate with 1250 psig, 825 F at the throttle. Steam is extracted at 425 psig and again at 165 psig. The unit exhausts at 25 psig.

Simple Condenser Proportioning

By W. H. ARMITAGE,
Application Engineer,
Blower and Condenser Department, Allis-Chalmers Mfg. Co.

FINAL PROPORTIONS of a steam surface condenser are usually the result of a carefully worked out set of formulas. To figure these may be a fairly long job. With the recently-adopted standard condenser surfaces and tube lengths, as shown in Table I, the first solution by these formulas may not meet the standards, so further calculations, by changing water velocities, must be made until they do so.

To simplify this procedure for preliminary proportioning, a set of charts has been drawn up, as listed in Table III, plotting the results of the above formulas, so that final proportions can be calculated quickly and with an accuracy sufficient for close estimating purposes. Figures 2 and 3 show two of these charts large enough for direct reading. The method of use is indicated on Fig. 1.

Space limitations, in many instances, may govern the selection of the tube length; in other cases, power required for pumping circulating water may determine the tube length. Some installations may be free of all limits. Table II shows suggested tube lengths if no limits exist.

Table I. List of standardized surface condensers available, with various tube lengths for each size

Standard Condenser Surface Sq Ft	may have any of these Tube Lengths Ft	Standard Condenser Surface Sq Ft	may have any of these Tube Lengths Ft
100	6	7250	16
200	8	7500	18
300	10	7750	20
400		8000	22
500	6	8500	
600	8	9000	
700	10	9500	
800	12	10,000	
900		11,000	
1000	8	12,000	
1100	10	13,000	
1200	12	14,000	
1300	14	15,000	18
1400		16,000	20
1500		17,000	22
1750		18,000	24
2000	10	19,000	
2250	12	20,000	20
2500	14	22,500	22
	16	25,000	24
2750	12	27,500	26
3000	14	30,000	22
3250	16	32,500	24
3500	18	35,000	26
3750		37,500	28
4000		40,000	
4250		42,500	
4500		45,000	
4750		47,500	
5000	14	50,000	24
5250	16	55,000	26
5500	18	60,000	28
5750	20	65,000	30
6000		70,000	
6250		75,000	
6500		80,000	
6750		85,000	
7000		90,000	
		95,000	
		100,000	

Table II. Recommended tube sizes for various steam flows to condenser

Lb/Hr Steam to Cond.	Effective Tube Length — Ft.*											Tube Diameter
	10'	12'	14'	16'	18'	20	22'	24'	26'	28	30	
25,000	X	X	X									¾"
50,000			X	X	X							
75,000				X	X	X						¾" or
100,000				X	X	X						
125,000				X	X	X						⅞"
150,000					X	X	X					
175,000					X	X	X					⅞"
200,000						X	X	X				
225,000						X	X	X				
250,000						X	X	X				
275,000						X	X	X				
300,000							X	X	X			
350,000							X	X	X			
400,000							X	X	X			
450,000							X	X	X			1⅛" or
500,000								X	X	X		
550,000								X	X	X		
600,000								X	X	X		
650,000								X	X	X		
700,000									X	X	X	
750,000									X	X	X	

*The longest lengths are generally recommended for single pass and the shortest for two-pass condensers.

Determining Maximum Possible Vacuum

A condenser may be guaranteed only to maintain a maximum vacuum that will correspond to a saturation steam temperature equivalent to the inlet circulating temperature, plus temperature rise through condenser, plus 5 F terminal difference.

Example: Determine the maximum vacuum for a condenser using 70 F circulating water temperature, with a 14 F rise.

$$70 + 14 + 5 = 89 \text{ F}$$

Steam pressure corresponding to 89 F = 1.38 Hg abs.

30 — 1.38 = 28.62 Hg vacuum, referred to a 30-in. barometric reading.

Charts Available

The available charts listed in Table III can be used for determining the size of a condenser designed for 1.0 in. Hg, 1.5 in. Hg, and 2.0 in. Hg absolute pressure. Velocities between 6 and 7 fps (feet per second) are considered good practice. If no tube lengths are specified, refer to Table II for recommended lengths.

Steps in Using Charts

Use of these proportioning charts is illustrated in Fig. 1. Here are the steps in order.

Step 1—Velocity of circulating water must be known or assumed. Locate it on Scale V. Then place a straight edge through the point on Scale V, make it pass through a point on Scale T, Fig. 1, representing the specified or assumed tube length for the circulating water temperature given; and continue the line until it intersects vertical Scale W.

Step 2—On W, read the pounds of

steam condensed per hour per square foot of surface.

Step 3—If the cleanliness is other than 100 per cent, then multiply the W value by the correction factor corresponding to the cleanliness.

Step 4—Take this final value and divide it into the pounds of steam the condenser must handle per hour. The result is the total square feet of surface required in the condenser.

Step 5—Check this surface in Table I. If it is found not to be a standard listed size, take the closest surface listed and divide it into the number of pounds of steam the condenser must handle per hour to obtain the corrected loading.

Step 6—If a cleanliness factor is used, divide this new loading by the correction factor for cleanliness. Then find this new value on the vertical loading scale W.

Step 7—Lay a straight edge through the new W value and through the specified or assumed tube length for the proper circulating water temperature, Scale T, and draw a line until it intersects the vertical velocity scale V. Then read on V the final corrected velocity for a standard size surface condenser.

Step 8—Now, from the same charts, using only Scales V, L and G in the section "Circulating Water, Gpm," determine the total quantity

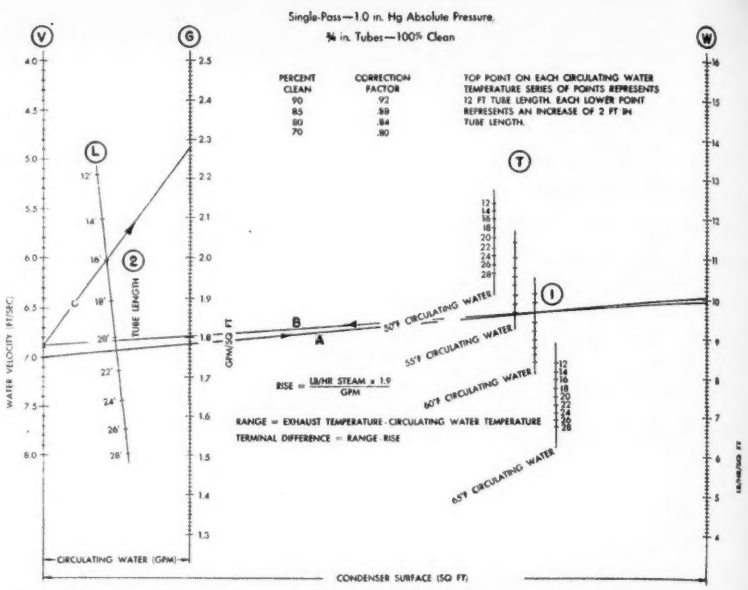

Single-Pass—1.0 in. Hg Absolute Pressure
¾ in. Tubes—100% Clean
PERCENT CLEAN
CORRECTION FACTOR
90 .92
85 .88
80 .84
70 .80
TOP POINT ON EACH CIRCULATING WATER TEMPERATURE SERIES OF POINTS REPRESENTS 12 FT TUBE LENGTH. EACH LOWER POINT REPRESENTS AN INCREASE OF 2 FT IN TUBE LENGTH.
RISE = LB/HR STEAM x 1.0 / GPM
RANGE = EXHAUST TEMPERATURE - CIRCULATING WATER TEMPERATURE
TERMINAL DIFFERENCE = RANGE - RISE
55°F CIRCULATING WATER
60°F CIRCULATING WATER
65°F CIRCULATING WATER
WATER VELOCITY (FT/SEC)
TUBE LENGTH
GPM/SQ FT
LB/HR/SQ FT
CIRCULATING WATER (GPM)
CONDENSER SURFACE (SQ FT)

Fig. 1. Condenser Proportioning Chart No. 53, showing method of use to find condenser surface, amount of circulating water required and other data, for a single-pass condenser, for 1.0 in. Hg absolute pressure, with ¾-in. tubes

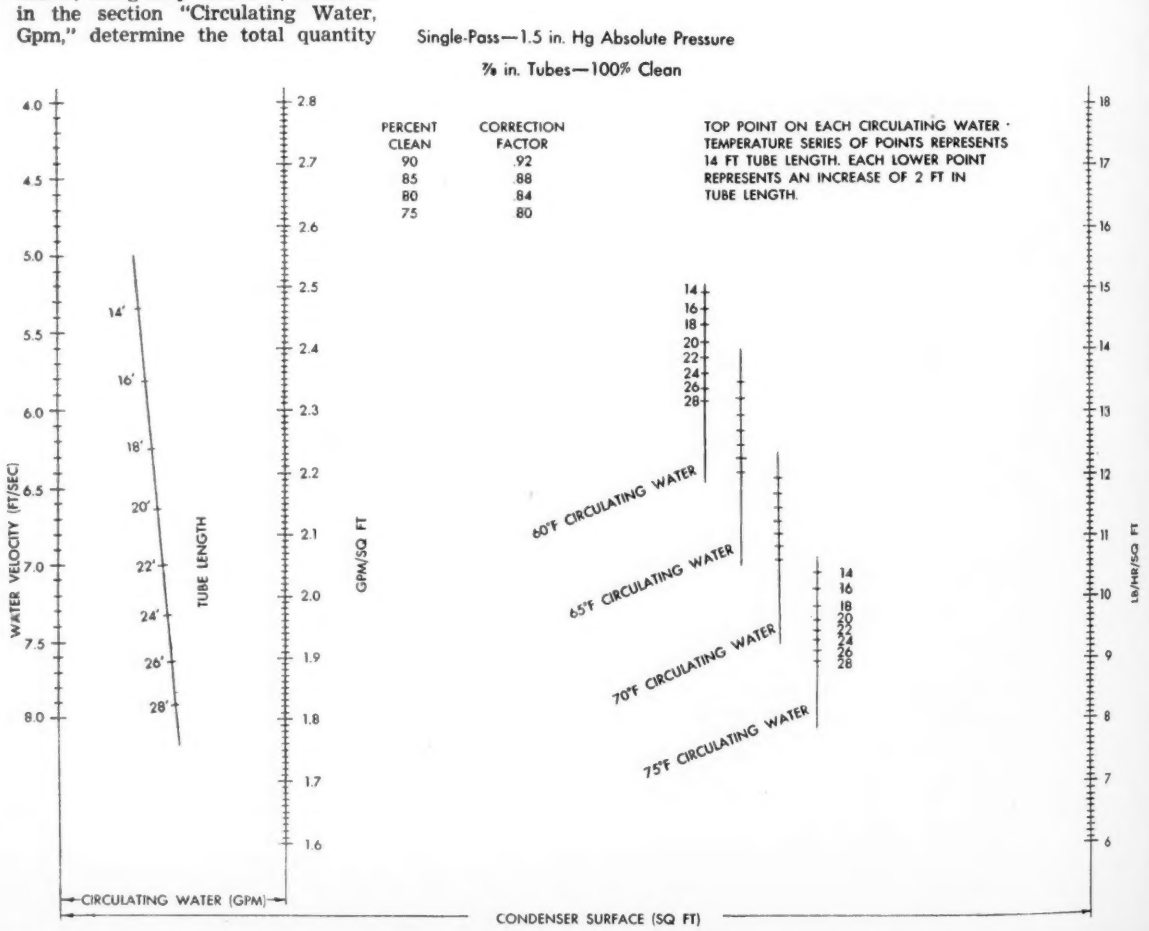

Single-Pass—1.5 in. Hg Absolute Pressure
⅞ in. Tubes—100% Clean
PERCENT CLEAN
CORRECTION FACTOR
90 .92
85 .88
80 .84
75 .80
TOP POINT ON EACH CIRCULATING WATER TEMPERATURE SERIES OF POINTS REPRESENTS 14 FT TUBE LENGTH. EACH LOWER POINT REPRESENTS AN INCREASE OF 2 FT IN TUBE LENGTH.
60°F CIRCULATING WATER
65°F CIRCULATING WATER
70°F CIRCULATING WATER
75°F CIRCULATING WATER
WATER VELOCITY (FT/SEC)
TUBE LENGTH
GPM/SQ FT
LB/HR/SQ FT
CIRCULATING WATER (GPM)
CONDENSER SURFACE (SQ FT)

Fig. 2. Condenser Proportioning Chart No. 57 for single-pass condenser,—1.5 in. Hg absolute pressure, ⅞-in. tubes. Method on Fig. 1

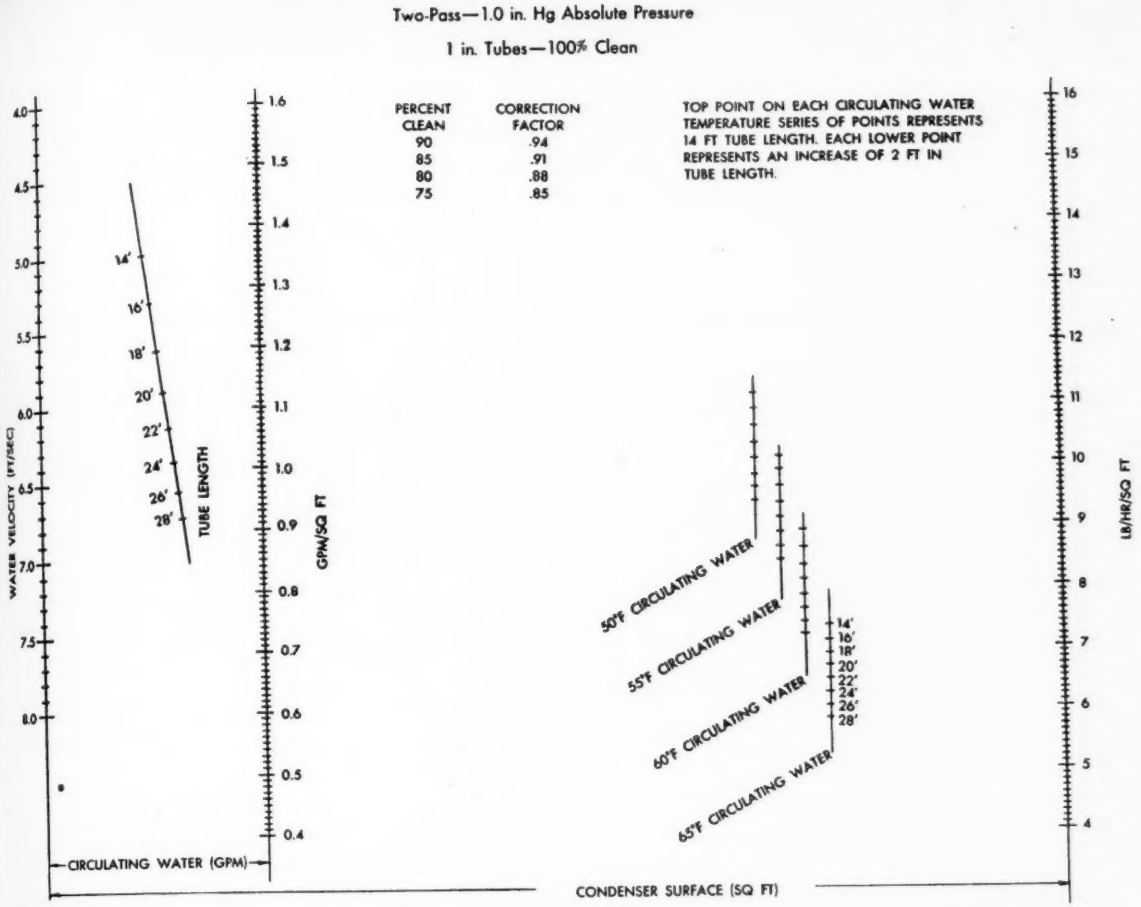

Two-Pass—1.0 in. Hg Absolute Pressure
1 in. Tubes—100% Clean
PERCENT CLEAN
CORRECTION FACTOR
90 .94
85 .91
80 .88
75 .85
TOP POINT ON EACH CIRCULATING WATER TEMPERATURE SERIES OF POINTS REPRESENTS 14 FT TUBE LENGTH. EACH LOWER POINT REPRESENTS AN INCREASE OF 2 FT IN TUBE LENGTH.
WATER VELOCITY (FT/SEC)
TUBE LENGTH
14' 16' 18' 20' 22' 24' 26' 28'
GPM/SQ FT
LB/HR/SQ FT
50°F CIRCULATING WATER
55°F CIRCULATING WATER
60°F CIRCULATING WATER
65°F CIRCULATING WATER
CIRCULATING WATER (GPM)
CONDENSER SURFACE (SQ FT)

Fig. 3. Condenser Proportioning Chart No. 68 for two-pass condenser,—1.0 in. Hg absolute pressure, 1-in. tubes. Method on Fig. 1

of circulating water required. To do this, lay a straight edge through the corrected velocity point on Scale V and draw a line through the proper tube length on Scale L, until it intersects Scale G. Read on Scale G the gallons per minute required per square foot of surface.

Step 9—Take this value and multiply it by the total square feet of surface previously obtained in Step 5. The result is the total quantity of circulating water required.

Table III. List of charts available for figuring condenser proportions. Charts 7 by 9½ in. will be sent without charge on request, by chart numbers, to Editorial Department, *Power Plant Engineering*, 53 W. Jackson Blvd., Chicago 4, Illinois

Chart No.	Vacuum In. Hg Abs	Circulating Water Temperature Range, Deg F	Tube Diameter, In.
	SINGLE-PASS CONDENSER		
53	1.0	50-65	¾
54	1.5	60-75	¾
55	2.0	70-85	¾
56	1.0	50-65	⅞
57	1.5	60-75	⅞
58	2.0	70-85	⅞
59	1.0	50-65	1
60	1.5	55-70	1
61	2.0	70-85	1
	TWO-PASS CONDENSER		
62	1.0	45-60	¾
63	1.5	55-75	¾
64	2.0	70-85	¾
65	1.0	50-60	⅞
66	1.5	55-75	⅞
67	2.0	70-85	⅞
68	1.0	50-65	1
69	1.5	55-75	1
70	2.0	70-85	1

Typical Numerical Example

EXAMPLE: To determine the size and gpm necessary to maintain a vacuum of 29 in. Hg, referred to 30 in. barometer, or 1 in. absolute pressure, with a single-pass surface condenser. Average circulating water temperature, 60 F; ¾ in. tubes are preferred; 70,000 lb per hr of steam to condenser at full-rated load. Per cent cleanliness, 85.

SOLUTION: From Table II we see that a tube length of 16 ft is one that is recommended, therefore we will use ¾-in. by 16 ft tubes. The next steps are numbered to correspond with the instructions given above.

1—A water velocity of 7 fps will be assumed. Now, referring to Fig. 1, Chart No. 53, draw a straight line A from 7 fps velocity, Scale V, to point (1) on the vertical 60 F circulating water line representing 16 ft, Scale T, and continue it to Scale W.

2—On W, read a value of 10.05.

3—Multiply 10.05 by 0.88 to correct for the 85 cleanliness factor. This gives a loading of 8.85 lb per hr per sq ft.

4—Now divide 70,000 lb per hr by 8.85 and obtain 7900 sq ft.

5—Since 8000 sq ft is the closest standardized condenser shown in Table I, divided 70,000 lb per hr by 8000 sq ft and obtain a loading of 8.75 per hr sq ft.

6—Now divide 8.75 lb per hr per sq ft by 0.88 the cleanliness correction factor for 85 per cent cleanliness and get 9.95 lb per hr per sq ft.

7—From 9.95 lb per hr per sq ft on Scale W, draw a line B through point 1 to Scale V and read 6.88 fps which is the corrected velocity for the 8000 sq ft condenser

8—To determine the gpm of cooling water, draw a straight line C from the velocity 6.88 fps, Scale V, to the 16 ft point (2) on Scale L. Continue this line to vertical scale G and read 2.28 gpm per sq ft.

9—Multiply 2.28 gpm per sq ft by 8000 sq ft to get 18,240 gpm of circulating water to the condenser.

Circulating water temperature rise, range, and terminal difference can be found from formulas on Fig. 1.

Skin Effect in Electrical Conductors

Basic theories underlying skin effect . . . Relative importance in different circuits . . . Skin effect in different types of conductors . . . Resistance values of annealed and hard drawn copper wire . . . Determination of skin effect ratio . . . Examples

By FRED C. DE WEESE

THE SUBJECT of "Skin Effect" in electrical conductors has been treated by such well known scientists and engineers as Lord Kelvin, Rayleigh, Dwight, and others.[1] The theoretical data and equations published by these various authors provides a basis for development of certain modifications from which values may be derived to give results which are applicable to actual conductor sizes under varying degrees of temperature, which is generally not otherwise the case.

Most of the previously published data, which has come to the attention of the writer, on the subject of skin effect, treats the problem at frequencies which are much higher than obtains in the generation and transmission of electric power. (60 cycles per second). The trend of thought has generally seemed to stress the fact that skin effect is relatively important only at high frequencies. For comparatively small conductors this is true, but for large conductors, as will be seen from the following treatment, it is extremely important. The methods to follow are universally applicable to problems involving a frequency of 60 cycles, since by their use, skin effect ratios may be derived for a wide range of conductor sizes at any desired temperature.

When an alternating emf is impressed on a cylindrical conductor maximum magnetic density will be at the center of the wire or cable and the magnetic center is linked by all the flux lines. The magnetic density diminishes toward the surface of the conductor, becoming minimum at the surface. It is well known that the greater the magnetic density, the greater will be the opposition to the flow of current. It is therefore obvious, since the IR drop must be the same at all points in the cross section of the conductor, as the magnetic density decreases from the center outward the current density increases from the center outward, becoming maximum at the conductor surface. The unequal distribution of current in the conductor produces an apparent a-c resistance greater than the d-c resistance. The ratio of the a-c to d-c resistance is called "Skin Effect Ratio."

For copper wire and cables the skin effect is a function of the frequency and cross-section of the conductor. For ACSR (Aluminum Cable Steel Reinforced) the steel core is not depended on to carry any of the current. The current carrying medium consists of one or more layers of aluminum strands surrounding the steel core, as a result of which skin effect is negligible.

Table I gives the resistance, in terms of ohms per mil-ft, for both annealed and hard drawn copper from 0 to 105C at intervals of five degrees. (105 degrees maximum permissible temperature.)

To convert the table values to resistance in terms of more practical units, proceed as follows: For solid wire multiply table value at any given temperature by 1000/cm; for three strand multiply by 1000/cm × 1.01; for seven and higher stranding multiply by 1000/cm × 1.02. Let it be required to find the d-c resistance, R_{d-c}, for a 500 mcm copper cable, both annealer and hard drawn, at a conductor temperature of 75 C.

Annealed, $R_{d-c} = 12.613 \times 2 \times 10^{-3} \times 1.02 = 0.02573$ ohm per 1000 ft $= 0.02573 \times 5.28 = 0.13585$ ohm per mile.

Hard drawn, $R_{d-c} = 12.898 \times 2 \times 10^{-3} \times 1.02 = 0.02631$ ohm per 1000 ft $= 0.02631 \times 5.28 = 0.13892$ ohm per mile.

The resistance at other temperatures is found in the same manner.

Before the skin effect ratio, which we will designate "S_k," can be determined it will be necessary to compute the value of a factor "x," the argument from which S_k, for any given condition, may be derived. Both x and S_k may be derived from the following equations:

$$x = \sqrt{8.1115\pi f/(R \times 10^9)} \qquad (1)$$

Where f is the frequency in cycles per second

R is the d-c resistance for a conductor length of 1 centimeter. This equation is a modification of that given at the bottom of page 58, Standard Handbook for Electrical Engineers, 7th edition.[2]

$$S_k = (1 + 1/12(x/2)^4 - 1/180(x/2)^8 + 11/10080(x/2)^{12}) \qquad (2)$$

Equation (2) is limited in its application to a maximum value of x in the order of 2. The last term may be omitted for values of x not exceeding about 1. This equation resolves itself into

$$S_k = (1 + 0.08333(x/2)^4 - 0.005556(x/2)^8 + 0.001091(x/2)^{12}$$

Let it be required to find

(a): x and S_k for a 500,000 cm annealed copper cable at 65 C

(b): x and S_k for a 4/0, 7-strand hard drawn copper cable at a temperature of 25 C.

Certain constants may be set up which will greatly simplify and shorten the work, as well as reducing to a minimum the probability of error.

[1] See Standard Handbook for Electrical Engineers, 7th Edition, pages 58 and 236. Also Bureau of Standards Bulletin No. 169, pages 176-177.

[2] The Standard Handbook equation: $x = \sqrt{8\pi f/(R \times 10^9)}$.

This article on skin effect should be of interest and value to all electrical men engaged in heavy power work. As Mr. DeWeese points out, skin effect is of relatively small importance in 60 cycle work where small conductors are involved but for large conductors it is extremely important. Most handbooks treat the subject of skin effect rather lightly and many authors have merely set up arbitrary values of x and in most instances these values of x do not correspond to values derived from accurate analysis of the conditions in a particular conductor. The method described here by Mr. DeWeese, to our knowledge, is the first attempt to bring the subject down to earth and put it on a plane whereby the average practicing engineer may be able to apply the method to his own problems. The author is General Engineer of the Carolina Power and Light Company and is the author of "Electrical Transmission Systems" and "Transmission Lines," the latter published in 1945

Table I—Resistance Per Mil-Foot at Various Temperatures

Temp Deg C	Copper		Temp Deg C	Copper	
	Annealed	Hard Drawn		Annealed	Hard Drawn
0	9.556	9.845	55	11.798	12.084
5	9.760	10.048	60	12.001	12.288
10	9.963	10.252	65	12.205	12.491
15	10.167	10.455	70	12.409	12.695
20	10.371	10.659	75	12.613	12.898
25	10.575	10.863	80	12.816	13.102
30	10.779	11.066	85	13.020	13.306
35	10.982	11.270	90	13.224	13.509
40	11.186	11.473	95	13.428	13.713
45	11.390	11.677	100	13.632	13.916
50	11.594	11.881	105	13.835	14.120

For example, the numerator of (1), at a frequency of 60 cycles, is equal to $8.1115 \times 3.14159 \times 60 = 1{,}528.9804$ (constant). The resistance per foot, (unit basis) = 1/5280 = 0.00018939 ohm. Since there are 30.48 centimeters in a foot, the resistance per centimeter length = 0.00018939/30.48 = $0.0000062137 = 6.2137 \times 10^{-6}$ ohm. The denominator of (1), $R \times 10^6$, is equal to the product of ohms per mile for the given conductor and 6.2137×10^3. This multiplier will also remain constant.

Solution for (a)

The resistance per mil-ft from Table I at 65 C is given as 12.205 ohms. Then $R_{d-c} = 12.205 \times 2 \times 10^{-3} \times 5.28 \times 1.02 = 0.13146$ ohm per mile. $R \times 10^6$, denominator in (1), is equal to $0.13146 \times 6.2137 \times 10^3 = 816.853$. Substituting in (1) and solving for x, we have

$x = \sqrt{1528.9804/816.853} = \sqrt{1.871793} = 1.368135.$

$x/2 = 0.68047$; $(x/2)^4 = 0.21898$; $(x/2)^8 = 0.04795$.

From (2)

$S_k = (1 + 0.08333 \times 0.21898 - 0.005556 \times 0.04795 = 1 + 0.018248 - 0.000266) = 1.017982$, (skin effect ratio) $R_{d-c} = 1.01798 \times 0.13146 = 0.13882$ ohm per mile.

Solution for (b)

From Table I the resistance per mil-ft for hard drawn copper at a temperature of 25 C is given as 10.863 ohms. The resistance of 4/0 hard drawn copper, which has a cross-section of 211,600 cir mils,

$R_{d-c} = (10.863/211.6) \times 5.28 \times 1.02 = 0.27648$ ohm per mile. $0.27648 \times 6.2137 \times 10^3 = 1{,}717.9638$

From (1)

$x = \sqrt{1528.9804/1717.9638} = \sqrt{0.889996} = 0.943396$

$x/2 = 0.471698$; $(x/2)^4 = 0.049506$; $(x/2)^8 = 0.00245$

$S_k = (1 + 0.08333 \times 0.049506 - 0.005556 \times 0.00245) = 1.004125 - 0.000014 = 1.004111$

$R_{d-c} = 1.004111 \times 0.27648 = 0.27762$ ohm per mile.

Equation (2) is limited in its application to values of x in the order of 2, or to a maximum conductor size of about 1000 mcm copper cable at a frequency of 60 cycles. When the cable is of such size that x is in excess of about 2, this requires the derivation of two additional values called "W" and "Y," in which case $S_k = x/2 \times W/Y$. W and Y may be derived from the following equations:

$$W = x/2\ [(1 + 0.16667(x/2)^4 + 0.002083(x/2)^8 + 0.0000055(x/2)^{12} + A)] \quad (3)$$

$$Y = x^2/4\ [(1 + 0.08333(x/2)^4 + 0.000694(x/2)^8 + 0.0000014(x/2)^{12} + A/10)] \quad (4)$$

For x in the range of 2 to 2.4 A = 0.00145. A/10 = 0.000145.

For x in the range of 2.4 to 2.71 A = 0.0025. A/10 = 0.00025.

For x in the range of 2.71 to 3 A = 0.00415. A/10 = 0.000415.

Let us run through the calculations for a 1500 mcm annealed copper cable having a temperature of 75 C; and for a 2000 mcm copper cable having a temperature of 25 C.

From Table I, the resistance per mil-ft at 75 C = 12.613 ohms, from which

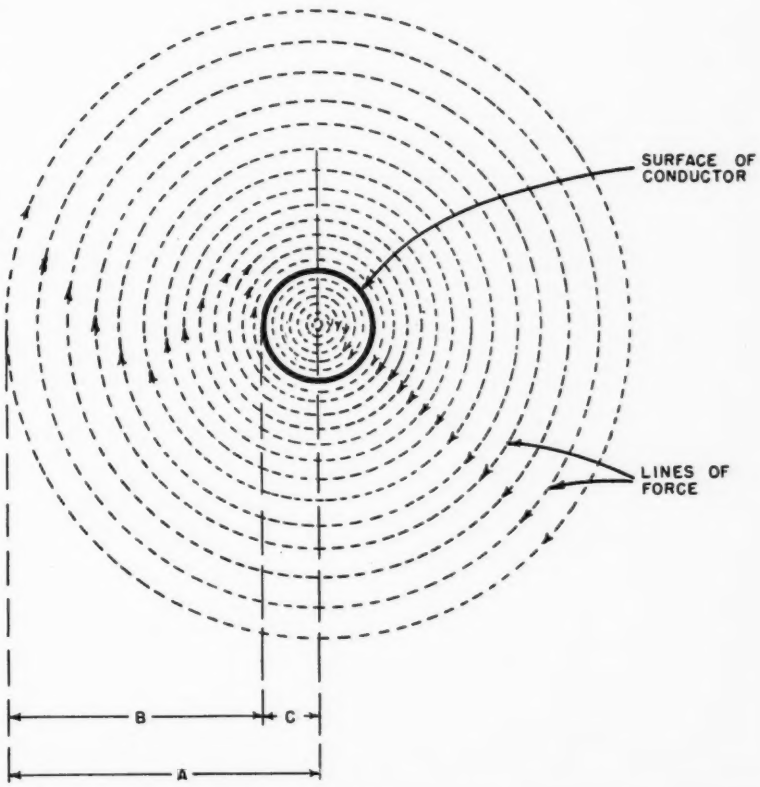


Diagram explaining skin effect. As is well known, a current in a conductor sets up a field of circular lines of force as shown in this diagram. With direct current, this field is uniform and unvarying. With alternating current, however, at the instant when the current is zero there is no field and, as the current increases during a cycle, the field of concentric lines of force forms and expands outward from the axis of the conductor. When the current decreases, the lines return to the center of the conductor and vanish. As the lines expand and contract they cut the conductor and produce self induction and skin effect. As will be evident, more lines cut the axis than the surface of the conductor. In this diagram a field is shown at its maximum value. All of the lines represented by A have cut the axis. Only those represented by B, however, have cut the surface. Since the field is maximum at this point, it will start to contract and, therefore, the lines within the conductor, represented by C, do not cut the conductor. Thus, there is a greater counter emf of self induction at the center or axis of the conductor than at its surface. This tends to force most of the current towards the surface. Where the conductors are large in cross section and the frequency high, practically no current exists at the center —nearly all of it is at the surface. (This illustration supplied by the Editor)

$R_{a-c} = 12.613/1500 \times 5.28 \times 1.02 = 0.045286$ ohm per mile for the 1500 mcm cable. The denominator of (1) $= 0.045286 \times 6.2137 \times 10^3 = 281.3936$.

$x = \sqrt{1528.9804/281.3936} = \sqrt{5.4336} = 2.33008$. $x/2 = 1.1655$.

$(x/2)^4 = 1.8452$; $(x/2)^8 = 3.40485$; $(x/2)^{12} = 6.2827$. $x^2/4 = 1.3584$.

From (3)

$W = 1.1655\ [(1 + 0.16667 \times 1.8452 + 0.002083 \times 3.40485 + 0.0000055 \times 6.2827 + 0.00145)]$

$= 1.1655 \times 1.31612 = 1.53393$.

From (4)

$Y = 1.3584\ [(1 + 0.08333 \times 1.8452 + 0.000694 \times 3.40485 + 0.0000014 \times 6.2827 + 0.000145)]$

$= 1.3584 \times 1.15629 = 1.5707$.

$S_k = x/2 \times W/Y = 1.1655 \times \frac{1.53393}{1.57070} = 1.13822$.

$R_{a-c} = 1.13822 \times 0.04529 = 0.05155$ ohm per mile.

The resistance per mil-ft at 25 C for annealed copper is given as 10.575 ohms. $R_{d-c} = 10.575/2000 \times 5.28 \times 1.02 = 0.028476$ ohm per mile for the 2000 mcm cable. Accordingly, $0.028476 \times 6.2137 \times 10^3 = 176.9413$.

$x = \sqrt{1528.9804/176.9413} = \sqrt{8.6411173} = 2.939587$. $x/2 = 1.4697936$; $(x/2)^4 = 4.66687$; $(x/2)^8 = 21.7796$; $(x/2)^{12} = 101.6427$.

$x^2/4 = 2.16029$.

$W = 1.46979\ [(1 + 0.16667 \times 4.66687 + 0.002083 \times 21.7796 + .0000055 \times 101.6427 + 0.00425)]$

$= 1.46979 \times 1.8280 = 2.68678$.

$Y = 2.16029\ [(1 + 0.08333 \times 4.66687 + 0.000694 \times 21.7796 + 0.0000014 \times 101.6427 + 0.000425)]$

$= 2.16029 \times 1.4046 = 3.03434$.

$S_k = 1.46979 \times \frac{2.68678}{3.03434} = 1.30144$.

$R_{a-c} = 1.30144 \times 0.028476 = 0.03706$ ohm per mile.

The above calculations are carried out to a higher degree of accuracy than would ordinarily be required. When a calculating machine is available the powers of x/2 are readily derived. Otherwise a table of logarithms will be required.

It is unfortunate that a simple equation cannot be set up to give results with a fair degree of accuracy over a wide range in the value of x. It should be pointed out, however, that from equations (1), (2), (3) and (4), in conjunction with the values in Table I, skin effect ratios may be derived with an error not to exceed about one in ten thousand for copper conductors up to 2,000,000 cir mils covering a temperature range of from 0 to 105 C.

For those who may find it necessary, or wish to do so as a matter of interest, the values in Table I may be used for computing the values and compiling tables of direct current resistance, skin effect ratios and alternating current resistance much more extensive than will be found in any of the handbooks.

The modified equations above referred to, and used throughout this paper, were developed by the author, and should be found especially helpful to those who may be concerned with computing the effective resistance and losses in heavily loaded cables operating at high temperature, such as indoor installations, vaults, etc.

NEW STANDARDS FOR "WORKABILITY INDEX" OF FIRECLAY REFRACTORIES

AN IMPORTANT requirement of fireclay refractory is that it flows without cracking while being rammed into molded shapes or furnace walls and yet does not deform under its own weight during subsequent drying.

The Refractories Laboratory of the National Bureau of Standards conducted an extensive investigation of the reliability of the test method now accepted as standard. Results of tests on nine plastic refractories by R. A. Heindl and W. L. Pendergast have provided basic data for use in revision of the method and techniques of testing such plastics.

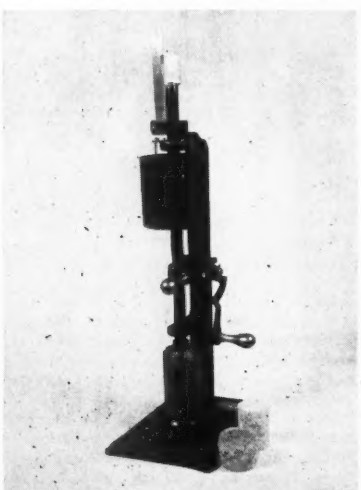


Fig. 1. The sand rammer used in the determination of the "workability index" of fireclay plastic refractories. The instrument has a scale for measuring deformation and 14 lb weight for impacting

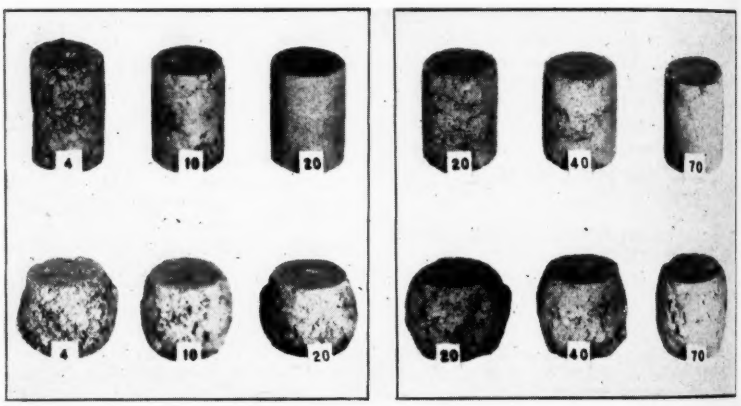


Fig. 2. Specimens of two brands of fireclay plastic refractories before and after "workability index" tests by the Refractories Laboratory of the National Bureau of Standards to determine the reliability of the present standard method of test. The label accompanying each specimen refers to the number of impacts it received during forming

A "workability index" has been designated by the ASTM. The instrument used for determining the index, the "sand rammer," is so called because of its use in the testing of foundry sands. The first step is the ASTM test of plastic refractories involves the molding of a standard 300-gram cylindrical test specimen with 20 impacts (10 on each end) of a 14-lb weight. Immediately after removing the specimen from the mold, and measuring its length, it is subjected to three additional impacts after which it is again measured. The plastic deformation computed from the difference in lengths and expressed in per cent, is the workability index. The specified permissible range of this index is from 15 to 35 per cent.

Obtaining a cored sample with a steel tube gave information on the extent of moisture variation in the plastic from top to bottom and across the 200-lb container. One plastic had an over-all moisture variation from 8.1 to 9.9 per cent with an average of 8.4 per cent. The interior of the steel mold for forming the test cylinder should be machined smooth and a ¼-in. steel disc, made to fit the interior snugly, placed at each end of the test specimen during forming.

The PRACTICAL ENGINEER and ELECTRICIAN

ANDREW W. KRAMER, EDITOR

☆

NEW SUPER Q & A SECTION

We have just received a lot of swell questions and answers from our chief boiler inspector and thinking they may help some poor soul pass an examination, we pass them on. As a matter of fact they are too hot to keep. You will find them on page 95, but just to give you an idea of what they are like, here are a few taken at random:

Q-1. What is steam?

A. Hot air soaked in water.

Q-2. What is water?

A. Steam with hot air taken out.

Q-3. What is a vacuum?

A. The inside of a pipe pumped out.

Q-4. When should the feedwater heater be cleaned out?

A. When the water gets cooler while passing through it.

You see what we mean? These questions and answers are really something and if you study them carefully you will pick up more misinformation than you could get any other way. Of course, these answers are more or less confidential and we do not guarantee them. Neither do we assume any responsibility for what they may get you into if you try to put them in practice. From here on, you are entirely on your own. Now turn to page 95.

☆

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A Section of Power Plant Engineering Devoted to PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 W. Jackson Blvd., Chicago 4, Ill.

So You're Buying a New Boiler?

What factors will govern the type of setting or enclosure you select?

By GEORGE P. REINTJES

AFTER MANY YEARS of experience in designing and building industrial furnace enclosures throughout the United States, the writer has learned that there are specific reasons which influence the selection of most enclosures. Surprisingly enough, some of these reasons have so little real importance that it is hard to believe they could be the determining factor in a purchase involving thousands of dollars.

Principally these facts are:

(1) In which locality is the furnace or boiler to be constructed?
(2) What is your industry?
(3) How competitive are the fuels in your area?
(4) Are you buying a boiler or furnace on price?
(5) Is the buyer a City, State or Government institution? In other words, are you eligible for a pension?

Expanding on these reasons, and beginning with number one, we are all creatures of habit . . . and some sections of our country have a remarkable resistance to change. Some plants in those areas explain that their settings are laid by an "expert" brickmason. He is an "expert" because he learned his trade from his father, who in turn was an "expert" in the old country, and so on. Naturally, these plants end up with settings which were considered modern a generation or two ago in the old country.

In certain areas of the country where there is a surplus of brickmasons, solid walls are of course predominant. In these same areas contractors almost seem to be allergic to employing any other craft required in the building of a modern boiler wall. In these sections where habit is strong, even consulting engineers cling to old established traits and specify gravity walls.

"I GOT A IDEA, LEM,— IF I WAS YOU, I'D USE RUBBER BRICKS FOR HEADERS—THEN YOU CAN TIE THEM RED BRICK TO THEM FIRE BRICK— EVEN IF THEY AIN'T THE SAME THICKNESS"
JONATHAN, I BELIEVE I'LL GET A PATENT ON YOUR IDEA— —AND WHEN THAT RUBBER STRETCHES IT'LL PULL MY WALLS BACK— AND KEEP THEM FROM FALLIN'

Fig. 1. You can't tie fire brick and red brick of un-uniform sizes together

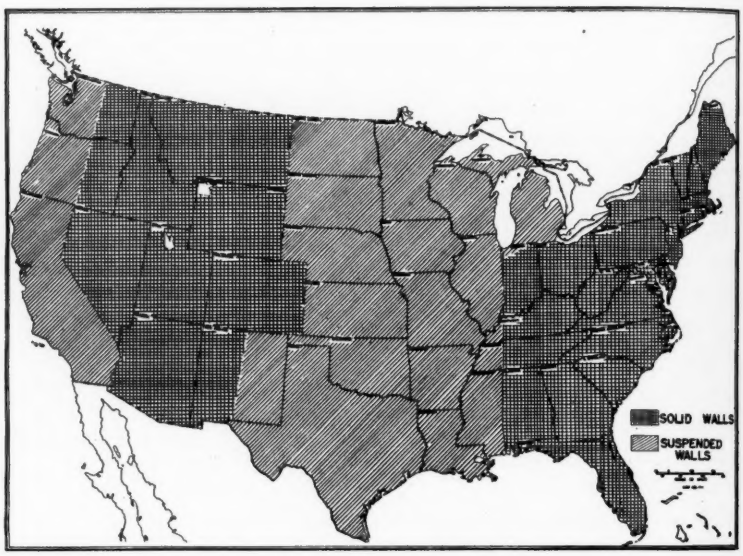


Fig. 2. Map showing where suspended walls predominate

Production industries, the automotive industry, for instance, watch costs in pennies per unit—likewise their Btu consumption. As an example, Ford Motor Co. and General Motors Corp. have replaced almost 100 per cent of their gravity walls with sectionally supported structures. The oil industry has discarded practically all of the older type wall constructions in favor of suspending by units all walls and arches for its furnaces. Industries whose production is highly competitive invariably rely on suspended walls and arches because of their high efficiency and lower maintenance costs.

How Competitive Are the Fuels in Your Area?

The lowest cost fuel per Btu is coal, except in very small areas. But to this cost must be added the cost of handling and ash disposal. The cleanest of fuels is natural gas, the medium priced fuel. Oil is highest in cost. Governing factors? Yes, but to fuel costs must be added costs of enclosure maintenance. Certain types of coal firing are more destructive to refractory walls and require more maintenance than others. For instance, burning the coal in suspension permits molten slag to wash down the side walls. This molten slag combines chemically with the refractories, eroding the inner surface. The underfeed stoker is the least destructive method of coal firing, as the ash remains on the stoker bed. Oil and gas are particularly destructive because of the rapid temperature fluctuations. This induces vitrifying and shearing of the refractories. Also, in the case of gas and oil firing, pulsations and vibrations, (due to numerous small explosions) quickly shatter a rigid solid wall structure. (There is no flexibility to absorb pulsation). Consequently, combustion engineers of gas companies are particularly active in seeing that their consumers have the best possible wall enclosure to conserve gas fuel; realizing that to

"THEM ENGINEERS SURE SPENT A LOT O' TIME FIGURIN' ON TH' PRESSURE O' TH' BILER AND HOW CHEAP THEY COULD BURN COAL ON TH' STOKER— WHERE DOES YOUR WALLS COME IN TH' PICTURE, LEM?

Fig. 3. The enclosure is also important—the entire efficiency of the boiler and firing equipment is dependent upon it

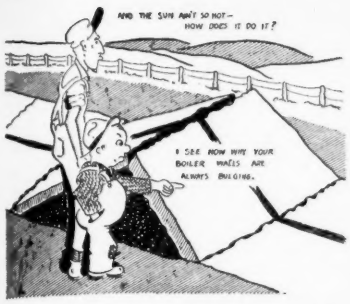


Fig. 4. The forces of expansion cannot be stopped

sell more gas at a profit, they must teach their new customers to use less gas.

Are You Buying a Boiler on Price?

Boiler manufacturers build pressure parts of boilers. Accessories,

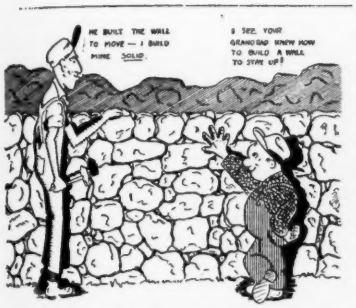


Fig. 5. An old fashioned stone retaining wall laid without mortar will contract and expand with weather as well as relieve pressure from behind it. It will stand up for generations

such as an enclosure to retain heated gases, are a necessary evil, so far as the salesman of the boiler company is concerned. At the time of the sale, a boiler manufacturer, agrees to produce steam at a certain efficiency and at a certain capacity. Whether or not this is accomplished is determined by a test, or trial run. If the conditions are met after a period of a 24 hr test, the boiler manufacturer is relieved of further responsibility. If the boiler salesman knows that most any type of wall will last long enough

Fig. 6. A solid wall without expansion joints and without ability to relieve itself of pressure will soon collapse

Fig. 7. Failure of furnace wall built of outer red brick and inner fire brick. Note where ties or header brick are rigid they have sheared. Where headers are loose they move up and down. Note burned out metal tie rod

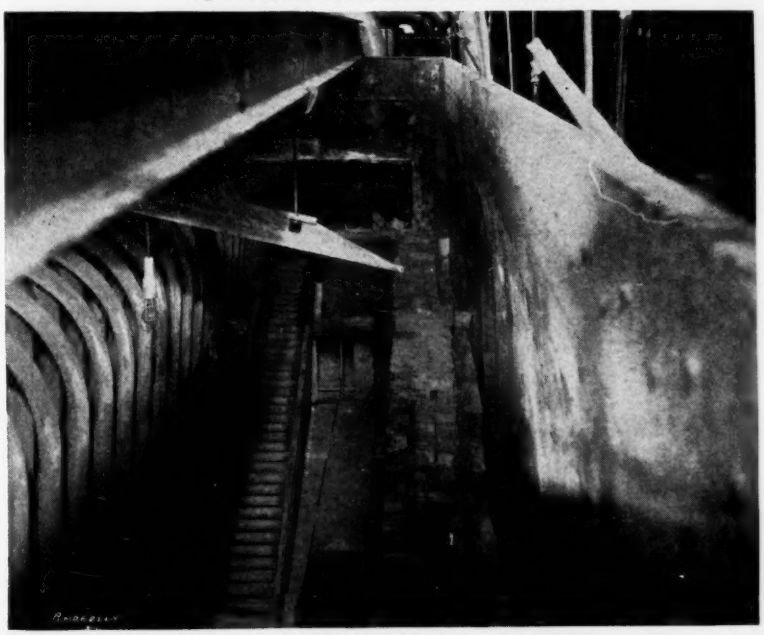


Fig. 8. Metal casing conceals solid wall failure

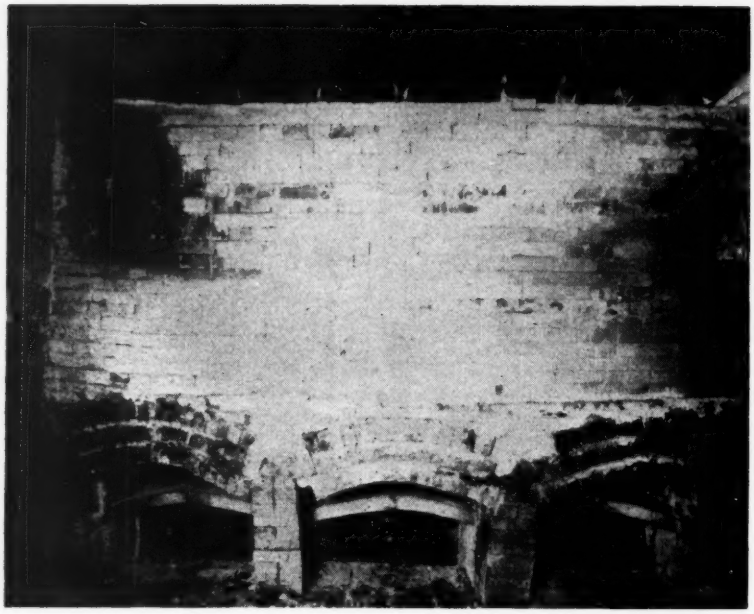
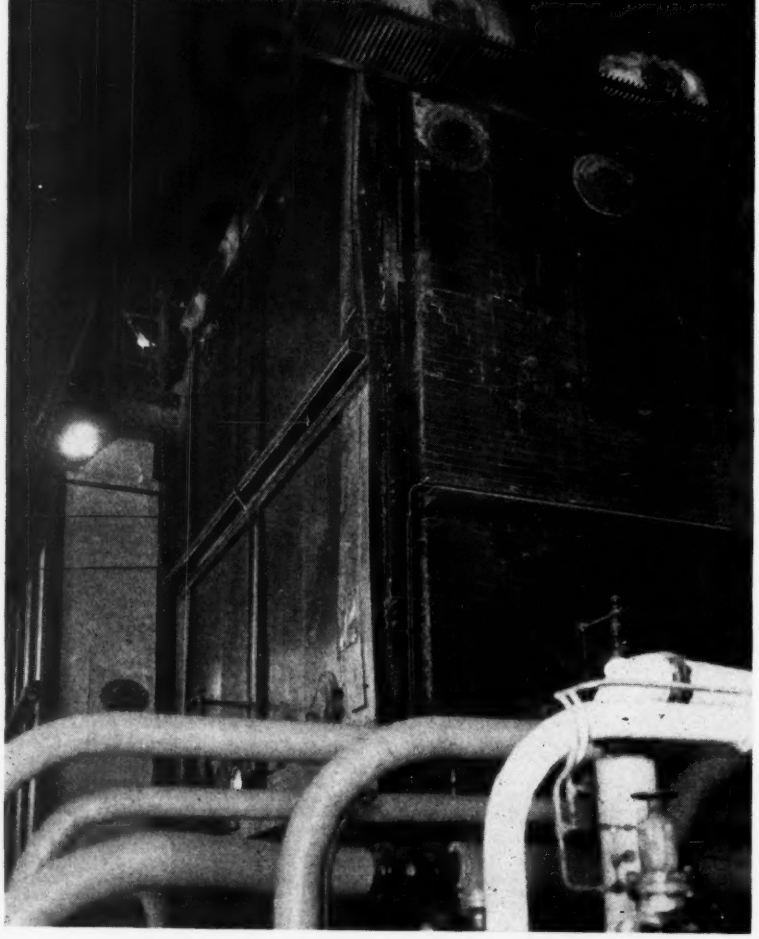


Fig. 9. Failure of piers due to concentrated load. The ordinary refractory under load softens at from 200 to 400 degrees lower temperature than the same refractory without load



to withstand an initial test run, why should he jeopardize securing the order by including the price of a correct setting, even though the latter might last the lifetime of his boiler. Thus, the lowest cost wins and it is not you who have selected the setting or enclosure, but the low dollar.

Are You a State, City or Government Institution?

If you are, then you must make purchases on the low dollar, or suffer the possibility of criticism. It's an evil of the system. It does not make any difference to you as an official whether or not settings or enclosures have to be replaced every few years, as long as you have followed in the footsteps of your predecessor and as long as you bought the lowest in first cost each time. There are some tragic but humorous results of this system. A few years ago, when our Government was making preparations for its vast expansion program, preparing for World War II, the writer was called in by one of the branches. In checking the specifications it was found that they were taken from a project of World War I. Further checking brought forth the discovery that the World War I specifications were briefed from a project of the Spanish American War! This story was told to an ex-president of the American Society of Mechanical Engineers, who had been called in by one of the departments. His remark was, "Oh, that is modern." When I checked through the plumbing specifications I found some that had dated back to the "Civil War." In this classification, it is not you, or your better judgment which will rule the selection, but it is your predecessor who could do no wrong in following in the footsteps of the man he succeeded, and so on.

Because most of us have a tendency to follow the course of least resistance, it is only through bitter and costly experience . . . and ever-increasing fuel costs . . . that some of us stop and consider what type of setting or enclosure is correct for any specific installation. We all know full well that all of the money spent for fuel is consumed within the furnace walls and outside the pressure parts of the boiler. Efficiency of combustion then means profitable operation —inefficiency is waste going up the stack.

What are the advantages or disadvantages of various types of gas-retaining furnace enclosures? Does it require special engineering knowledge or just practical "horse sense" to know the difference? Many times you have seen a concrete retaining wall turn over from the weight of

Fig. 10. The fuel bill of the modernized boiler at the left was $500 per month less than the fuel bill of the right-hand boiler. Under present fuel costs, the savings increased

soil and moisture behind it. Yet, you have also seen an old stone wall laid up without mortar withstanding the pressures of an embankment for generations. You can heat a pane of glass to the melting point without cracking it. Yet, you can hold a lighted match at one corner of the glass and promptly crack it. These same principles hold true in a properly designed furnace enclosure: flexibility, freedom of expansion and contraction.

Everyone knows that the softening point of a refractory is dependent not only on the temperature to which it is subjected, but also the weight imposed on it. If you would divide a wall into suspended units, transferring the weight of each unit back to metal framework, you would automatically raise the softening point of the refractories . . . sometimes as much as 300 degrees Fahrenheit.

Cumulative expansion is an irresistible force. It "buckles" concrete highways, makes bridges "grow" longer, causes power lines to "sag" in summer heat. A refractory wall should be free to move with a provision for absorption of expansion with joints, not just horizontally, but in a vertical direction as well. Only a suspended wall can provide *both* horizontal and vertical expansion joints. Your consulting engineer wouldn't allow designing your office or warehouse building as four slabs without using the corner angles in each corner for strength. Yet, the same engineer when building a solid gravity wall will invariably design the boiler settings with open expansion joints in the corners, placing buckstays on the outside to keep these slabs from falling outward. The walls do not fall outward, instead they fall *inward.*

In an overall consideration of various types of furnace enclosures, what are the disadvantages of sectionally supported walls? What are their limitations? Largely, one disadvantage is the lack of standardization of parts, and secondly, many systems in suspended walls require tailor made designs to enclose a particular boiler or furnace. Of the many wall and arch companies, only a very few have simplified standardized parts.

Are suspended walls the complete answer to all enclosure problems? No. In an ordinary boiler under normal operation, where heat release does not exceed 15,000 Btu per cu ft of furnace volume, and where the height of the wall in feet is not greater than the thickness of the wall in inches, an ordinary gravity wall is usually satisfactory. And, if the heat release does not exceed 25,000 Btu per cu ft of furnace volume, any sectionally supported wall can be satisfactory. For heat releases beyond this capacity, special considerations are required. If the heat release in the furnace is in excess of 35,000 Btu per cu ft of furnace volume, then consideration should be given to installation of water walls to reduce the furnace temperature. Incidentally, the trend in larger industrial applications is to this latter type of wall, and it should be discussed here briefly. The type of enclosures used in back of water walls must, of necessity, vary with the spacing of the tubes, and provision must be made for the direction in which the tubes expand. In some boiler designs, water wall tubes absorb their expansions by bending of the tubes within the furnace. In others, the boiler and the water wall tubes are supported near the top of the boiler and all expansion is in a downward direction within the enclosure framework. In these cases, the enclosure problems are relatively simple, but if the boiler or water walls are supported at the base and expand upwardly and away from the walls, then the wall enclosure design must be sufficiently flexible to expand and travel with the tubes and the boiler.

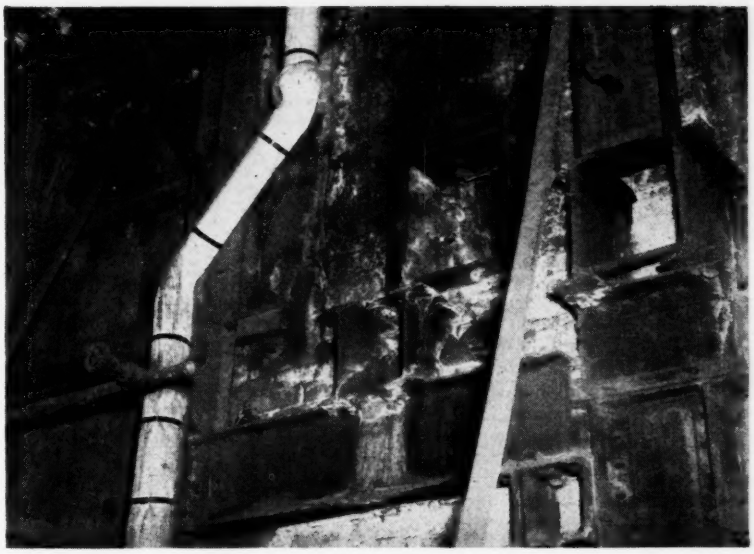


Fig. 11. The owners thought they saved money. Their added fuel costs changed their minds but too late

Editor's Note.—In the near future, POWER PLANT ENGINEERING will present an article describing various designs of building heat enclosures. The article will endeavor to show how various manufacturers of wall enclosures have solved problems covered here. No doubt a quick study of these designs will show that we have progressed but little since man's first attempt to enclose fire, and that we have yet a long, long way to go before true perfection is reached.

A NEW RADICALLY different lens for motion picture cameras can be adjusted by the cameraman to take scenes varying from panoramas to telephoto shots without changing lenses and interrupting continuity.

INCREASES OF 40 per cent or more above the best present practice in the efficiencies of automobile power plants are expected from the application of improvements in fuels and engines already in sight or actually in the experimental stage now.

AN INSULATION FAILURE on a generator at the Olmsted plant of the Utah Power and Light Company recently started a fire. The resulting heat distorted the coils in such a manner as to cause them to strike the rotor of the generator, which in turn drove them into a cooling water line to one of the bearings. The line broke and shot water into the rotor. The whirling rotor threw the water around the generator, thus putting out the fire.—*Electrical World*

That Furnace is the Most Efficient which completely consumes the combustible with the least surplus of air.

Jos. W. Hays

Lineman Is Saved by Pole Top Method

By H. F. LOVERING

DUE to a fellow workman's expert knowledge of what to do in an emergency and his skill in applying that knowledge promptly, James Griffin, New England Power Service Co. lineman, is alive today.

The scene for this highly dramatic rescue was laid in a suburban area in Warwick, R. I. Here a Service Company line crew and a similar crew from The Narragansett-Electric Co. were engaged in making changes to improve electric distribution construction.

Griffin and his rescuer, Burton J. Smith, both first class linemen, were working on pole No. 26 at the corner of Warwick and Harding Avenues with James E. Handy and Charles E. Fleury attending them as groundmen near the base of the pole. Foreman John E. Healey and other members of his crew were busy with details of line work at near-by locations.

The two men on whom interest centers, had removed a double six-pin primary buck arm and were preparing to replace it by a double eight-pin arm in a new lower position on the pole. One 4000 v wire and the primary neutral wire were held in grips attached to two insulator pins in a cross-arm higher up on the pole.

Rubber line protectors or hose had been placed on street light and primary wires adjacent to the work area, but a short section of one primary wire, where it had been removed from the crossarm, had not been covered. Three low voltage secondary service wires to a near-by customer's premises led off the pole at a point a little below where the men were working. These secondary wires were not covered by rubber hose.

In order to get into position to handle the new crossarm which Handy and Fleury were sending up, Griffin straddled the secondary neutral wire. Then, in moving about slightly, he brushed his shoulder, covered by a perspiration-soaked shirt, against the section of 4000 v wire not protected by line hose. He might have "got away with it" on a cold dry day with a couple of layers of woolen cloth between him and eternity. But on a hot summer day the situation was virtually atomic in death-dealing possibilities. Griffin "blacked out" instantly.

Bad off as he then was, fate dealt the victim a second and harder blow. Unconscious and helpless, he fell back with his neck firmly against the 4000 v wire. This contact teamed up with the other contact at the inside of his right leg against the secondary neutral wire to create a perfect path to ground.

From his position opposite the victim Burton Smith heard the roar of the electric arc, saw Griffin "frozen" to the wires and readily sensed his peril. Following with instant action, Smith swung around the pole by his safety strap into a position partially behind Griffin, knocked him clear of contact, pushed the primary wire out of the way, grasped the limp and breathless body around the waist from behind and *started pole top resuscitation.*

All this was done in less time than it takes to read that last paragraph. This is said by way of emphasizing the value of this latest life-saving method now in the head, hands and heart of the present-day lineman. Just picture the delay in providing relief to oxygen-starved lungs when, under the old method, it was necessary to lower a victim of electrocution on a pole to the ground before the prone pressure method could be applied, frequently five to 10 minutes. Now relief is given much more quickly than ever before under almost any conditions.

In this case for the first minute or two Griffin showed no signs of life. But within three minutes, as men best judge time under stress, Smith was rewarded by signs that the victim was coming back. Soon a few incoherent words were spoken by Griffin. But Smith, who still "knew what to do and did it" kept on with "pole top."

Meanwhile, other members of the crew had sprung into action. Fleury and Handy at the base of the pole had also heard the arc and had seen what followed. They called out to Peter Corliss, their truck driver, one pole section away. Corliss, in turn, ran one section further and summoned Foreman Healey, who hurried to the scene, telling Corliss to call other Service Company men near-by. Also responding promptly in the emergency were members of a Narragansett line crew under Foreman Michael E. Tulley.

Arriving at pole No. 26 in about a minute from the time of the accident, Healey quickly sized up the situation and told Smith to continue pole top resuscitation. The first linemen to arrive equipped for climbing were Fabian S. Gendreau of Healey's crew and Joseph P. Bradley of Tulley's crew. These men were sent up the pole at once. As Smith continued with resuscitation they rigged Griffin's safety belt and strap with a rope, making a "saddle hitch" sling in the approved manner for lowering the injured man.

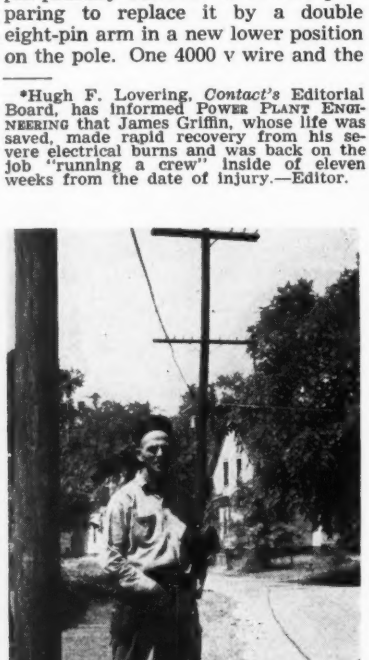
By now four or five minutes had elapsed and Griffin was rapidly regaining consciousness and the ability to breathe under his own power. It was therefore not considered necessary to continue the alternate pressure and release as he was being lowered to the ground.

Placed on a blanket, Griffin was given relief by the prone pressure method as a precautionary measure until the arrival of an ambulance summoned by a local police officer. Theodore Muller, Fabian Gendreau, Victor Erickson and Carl Graff cooperated in prone pressure application. The three other than Gendreau were members of the Narragansett crew.

Pete Corliss applied ointment as first aid for Griffin's severe burns. James Handy and Timekeeper Howard Cutler rode in the ambulance to the Rhode Island Hospital in Providence, but by then Griffin was breathing normally and seemed reasonably conscious.

It has taken a little telling but all that has been told took less than 20 minutes! And by 11:30 James Griffin, snatched from death, lay safe in a hospital bed. He may be there some long days to come. His recovery from the deep searing burns of an electric arc may be slow and

*Hugh F. Lovering, *Contact's* Editorial Board, has informed POWER PLANT ENGINEERING that James Griffin, whose life was saved, made rapid recovery from his severe electrical burns and was back on the job "running a crew" inside of eleven weeks from the date of injury.—Editor.



This is Rescuer Burton J. Smith

painful. But, thanks to Burton Smith and his priceless knowledge of "pole top," Griffin lives to climb again, as he has expressed it himself.

The Pole Top Method was introduced on the System seven years ago to supplement expert knowledge of the Schafer Prone Pressure Method which had been widely acquired and successfully applied on a number of occasions. During those seven years there has been a feeling that, sooner or later, there would be an opportunity to say, "Well, that certainly paid dividends."

Every time another line crew was trained and started in on regular monthly practice someone has said, "Hope you never have a chance to use Pole Top but there it is—just in case!"

Well, all this paid off bountifully for James Griffin and Burton Smith on June 26. By "all this" we mean "quick thinking, expert knowledge and intense desire to save the life of a co-worker and buddy" to quote the Edison Electric Institute which first gave us the pole top technique.

Everything in connection with the handling of this case after the accident was commendable. The members of the entire cast played their parts perfectly. Others stood ready to assume role as needed. In this, our first successful example of pole top resuscitation, alertness, skill and teamwork combined to give the drama a perfect ending.

From *"Contact"*

FLAT AND BEVEL SEAT VALVE COMPARED

By Albert H. Moulton

APPLICANTS FOR engineers licenses are sometimes asked such questions as: which would have the greater relieving capacity, a flat seat or a bevel seat safety valve? Or why does a flat seat require less area for an equal grate area than a bevel seat valve?

Safety valves are now mostly bevel seat, but there are still quite a number of flat seat valves in use especially in some of the older boiler plants.

Massachusetts Boiler Rules carry tables giving comparative data of each type. To cite a case: a boiler carrying 150 psia and having 36 sq ft grate area is allowed a 3 in. flat seat safety valve. While a bevel seat valve under the same conditions requires a 3½ in. valve.

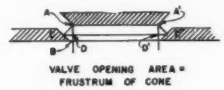
For conditions not met in tables they give these formulas:

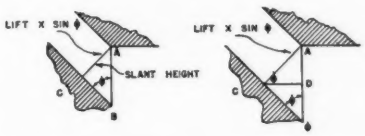
For flat seat valves $A = \frac{W70}{P} \times 8$

For bevel seat valves $A = \frac{W70}{P} \times 11$

Where A = Area of value in sq. in.
P = Absolute press lb sq in.
W = Pounds water evaporated per sq ft grate surface per second.

For bevel seat the effective valve opening as shown in the figure is equal to the slant surface of the frustrum of a cone whose upper base diameter AA' is equal to the diameter of seat opening. The slant surface is perpendicular to the seat, and since the height of the slant surface is less than the lift the capacity of a bevel seat valve is less than that of a flat seat valve.





Sin 45° = .7071 ∴ Effective opening of bevel seat = 70 per cent of flat seat valve.

For which slant height = lift × sin ϕ.[1] Now the area of valve opening or frustrum of a cone = slant height × angle × average base circumference (2). In fig. 1 the diameter of the lower base CC' is larger than the diameter AA' of the base by the distance $CD \perp C'D'$ or 2 CD from which $CD = CA\cos° = \text{lift} \times \sin \phi \cos \Theta$.

But since by construction $\phi = \Theta$ 45° and lift — ⅛ in. 2 $CD = 2 \times ⅛ \times \sqrt{½} \times \sqrt{½} = .25$ and calling the upper base diameter AA' unity.

$CC' = 1 \perp 1.20 = 1.125$ hence average base diameter = ½ (1 ⊥ 1.125) = 1.063

Slant height = ⅛ × $\sqrt{½}$ = 0.177

A WAR-DEVELOPED chemical compound forms an invisible "raincoat" over plastics, glass, paper, textiles, and other objects so that they shed water as easily as a duck. Recent tests in which 100,000 gallons of crude oil passed through a flow meter whose glass surface had previously been treated with the compound revealed that the glass had been unaffected even after a 10-day period.

"Hurry up and get through scratchin' your back and let's get this baby set up"

Practical Characteristics of the Mollier Diagram—V

By WALTER HEIDECKER

THE ABILITY of metals to withstand temperatures of 950 F made it possible to increase initial steam pressures to 1250 psia without having to reheat the steam before passing it through the low pressure section of the turbine. The 1250 psia increased the saturation temperature (boiling point) to 572 F making it possible to add 550 Btu per lb to the feedwater before it entered the boiler; 386 Btu per lb of this being recovered from the exhaust system of the turbine by means of small auxiliary condensers (heaters), the feedwater being the coolant.

Figure 1 is the diagram of a turbo-generator power plant similar to the specifications and general layout of the plant described on page 90, October 1944 issue, POWER PLANT ENGINEERING. The turbine is "blown up" into 6 sections and the "boiler" apparatus is arranged in a vertical column. The temperatures and pressures (absolute) in the system are tabulated and their locations shown on the Mollier diagram.

The method of controlling the temperature of the steam leaving the boiler is of interest. The boiler has 2 superheaters, the steam leaving the first superheater is divided—part of

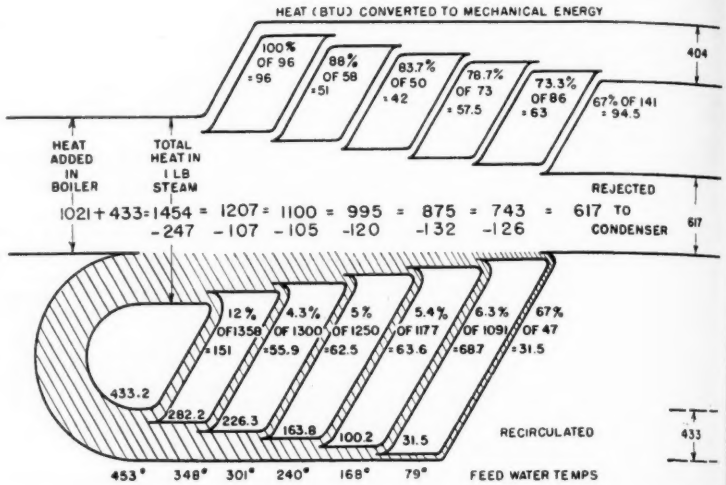


Fig. 2. Overall thermal efficiency of the turbine in Fig. 1 can be calculated from this flow diagram

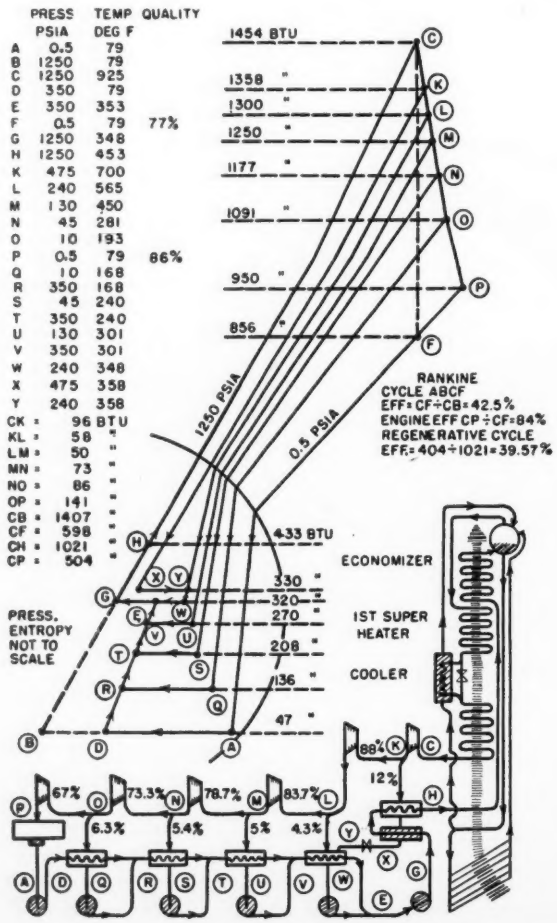
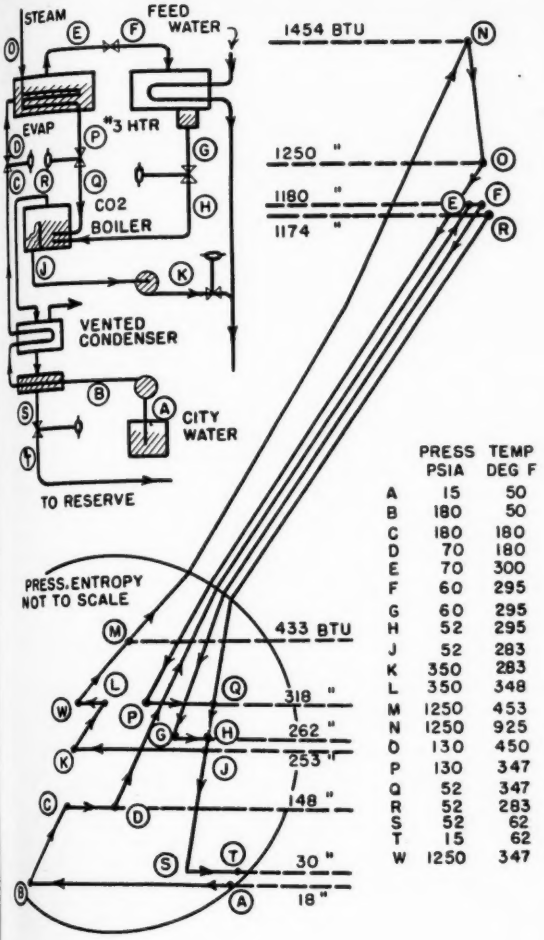


Fig. 1. Diagram of a turbine generator power plant. Note method of controlling the temperature of the steam leaving the boiler

the steam flowing through the cooler (attemperator), while the remainder flows through the bypass valve to the second superheater. As the steam flow is split, the flow through each branch will be inversely proportional to the resistance of the piping. When the bypass valve is wide open, most of the steam will pass directly to the second superheater, but when the bypass valve is partially closed, the resistance will be equal in both branches and the steam flow will be equally divided; closing the bypass valve will force more steam through the cooler. Referring to Fig. 1, the Rankine cycle is indicated on the Mollier diagram by the points ABCF. The Rankine cycle efficiency, CF (598) ÷ CB (1407) equals 42.5 per cent. This is near the maximum (43 per cent) that may be obtained by increasing the limits of the cycle. As this turbine is operating on a regenerative water cycle, its actual overall thermal efficiency can be calculated from the flow diagram Fig. 2—404 ÷ 1021 = 0.3957 or 39.57 per cent.

Breaking down the cycle into its circuits, we have 67 per cent of the steam flowing through the entire turbine to the condenser. This circuit (ABCP) is operating on a straight Rankine cycle with an actual thermal efficiency of 35.8 per cent—CP (504) ÷ CB (1407). If we divide CP (504) by CF (598) we will get 0.84 or 84 per cent, which we will call the engine efficiency of the turbine. The 5 remaining circuit operate upon 100 per cent thermal efficiency



	PRESS PSIA	TEMP DEG F
A	15	50
B	180	50
C	180	180
D	70	180
E	70	300
F	60	295
G	60	295
H	52	295
J	52	283
K	350	283
L	350	348
M	1250	453
N	1250	925
O	130	450
P	130	347
Q	52	347
R	52	283
S	52	62
T	15	62
W	1250	347

Fig. 3. This drawing shows the apparatus used to produce the distillate for use as "new" waetr in the system shown in Fig. 1

cycles returning to the boiler practically all of the heat not converted to mechanical energy.

Another point of interest in this power unit is the "open" makeup cycle not shown in Fig. 1. Water losses (boiler blowoff, gland leakage, etc.) must be replaced by "new" water, which in this case, is distillate. Figure 3 is a diagram of the apparatus used to produce the distillate. The temperatures and pressures (ABS) are tabulated and their locations shown on the Mollier diagram.

This really consists of 3 circuits, 1 steam closed cycle, and 2 city water open cycles. The steam (No. 1 circuit) is condensed in the evaporator giving up its heat of vaporization to the city water. The city water (No. 2 cycle) being changed into vapor, passes to the No. 3 heater, leaving behind solids which can be "blown down" when the evaporator is taken out of service.

The city water contains absorbed gases (mostly carbon dioxide) which do not remain in the evaporator, but pass through the cross-over pipe with the city water vapor into the No. 3 heater where they are absorbed by the drainage. The removal of these gases from the drainage takes place in the CO_2 boiler by a process called deaeration; that is, reducing the pressure of the vapor over the liquid below the saturation pressure of the water. The boiling water passes over a weir releasing the absorbed gases, which are carried away with the steam (circuit No. 3) to a vented condenser where the steam is condensed and the foreign gases are driven out through a vent pipe to the atmosphere. The drainage from the vented condenser passes through a regulating valve to a reserve water supply. The water from the CO_2 boiler is pumped into the feedwater line. The amount of vapor passing to the vented condenser is directly proportional to the city water flowing through its tubes. Thus a "steady state" flow must be maintained in all 3 circuits to make it work.

Referring to the rather complicated cycle diagram, HR (line) represents the "flashing out" of the steam in the CO_2 boiler, and RJ (line) represents the condensing of this steam in the vented condenser.

One Horsepower Questions with High Pressure Answers

By George L. Church
Chief Engineer, Water Pumping Station
East Mustache, Pennsafornia

(Continued from page 87)

5. What is a feed pump? That contraption which goes democratic when the load comes on and the glass is dry.

6. What is an injector? Worse than a pump.

7. What is the other name for these two appliances? Against the law to print it.

8. How much expansion is allowed on a boiler? All it can push out of the brick work.

9. What is coal? What you get from the coal dealer.

10. Name two kinds of coal. Good and bad.

11. Of what use is a bridge wall? It furnishes a topic for endless conversation at engineers' meetings when they get through with the lever safety valve.

12. What is the best depth for an ash pit? No one knows but college graduates, and all of them disagree. If it were as deep as a well, the firemen would let it fill up to the grates anyway.

13. How many kinds of boilers are there? Two: new and second hand.

14. Name a reliable way to get water into boiler. With a bucket.

15. How can you always maintain two gages of water? Close the lower cock.

16. Of what use is a check valve between pump and boiler? It gives the fireman a chance to say "She's stuck," when the boiler runs dry.

17. Suppose you noticed the cylinder head moving in and out half an inch, what would you do? Put a 2x4 from it to the wall.

18. What is a boiler inspector? A man who specializes in changing clothes, looks profound and finds fault with the safety valve.

19. Is he always reliable? Ab-solutely. He isn't there when the old kettle lets go, and can always prove there was no water in the boiler.

20. Suppose the safety valve blows excessively, what would you do? Plug it.

21. How do you set the valves on a Corliss Engine? Endways on the floor.

22. What is lead? Suppose that the boss was a natural-born horse's collar and everybody was cognizant of the fact but himself, and you, out of charity and the fullness of your heart, told him so—Well, the distance you get out the door ahead of him is called lead.

23. What is lap? Same as above, only around a dry kiln.

(To be continued)

A Sleeping Hazard Has a Bad Bite!!

An unguarded belt, a defective ladder, a grease spot on the floor, or a projecting nail can mess up your safety record and send the lost time accidents soaring to new highs. It takes more than the alert eyes of foremen and supervisors to dig out and correct hazardous conditions before they cause damage—workers also must take an active interest in task of locating as well as correcting hazards.

By JOHN G. REYNOLDS

AWAY, WAY back there when I was chopping my wisdom teeth on boiler feed pumps, air compressors and blow-off valves, my first boss said: "Son, don't be afraid of the equipment—you may hurt yourself but the machinery will not make the first move." That old boss of mine has since turned in his control panel experience for either a harp or a new kind of steam trap, but the truth of his statement is clearly proved by many of the accident reports that safety supervisors diagnose today.

In fact it requires only a careful study of the accident experiences of power plant employees to discover that in many cases workers have literally walked into accidents caused by hazardous conditions that have been allowed to exist without correction until they finally made work for the company doctor or the undertaker. Such items as an unguarded belt or gear, a defective ladder, an unlighted corridor, a grease spot on the floor, a hammer with a cracked handle, are among the long list of hazardous conditions that have contributed to recent accidents.

Rightfully, such potential causes of accidents should be discovered before they are directly charged with being the causative agents of deaths or injuries. And I know, without stepping one of my number 11's into your plant, that you have a special report for listing hazards, that your foremen keep their eyes peeled for anything that looks as though it might ruin the plant's "Safety Record"—but how about the workers? Are they alert to discovering and reporting hazards? Or, do they walk around a grease spot on the floor, forget to replace the burned out light, make a ladder "good as new" by taping up a broken rung?

Such actions are not the exceptions. The many varied reports on accidents caused by unsafe conditions clearly indicate that more attention should be devoted to locating and correcting potential causes of mishaps. And the entire job of locating hazardous conditions should not rest on the foremen. The workers must be active in observing and reporting any condition that may cause an accident.

The reports prove that although many power plants are supposedly devoid of hazards, constant vigilance is necessary to prevent the development of unsafe conditions. New construction must conform to the rules and regulations of various safety codes. Progress in engineering and construction practices have practically assured such conformity. But despite these advances the importance of checking properties for deterioration and the resultant formation of hazards should not be under-estimated.

A flight of stairs constructed 10 years ago may not be as safe today as when it was completed. Treads on the stairway may be loose or entirely worn out. Once smooth floors may be splintered and weakened. A fire escape installed years ago may be so rusted that it is incapable of operating properly, or new construction may have crowded it in such a manner that it cannot provide escape from danger.

Since it is practically impossible for any one man in an organization to know the exact time that a darkened hall needs a light, a machine needs a guard, or a belt needs replacement, the task of reporting hazards must be shifted to the workers. They are in daily contact with the machines, the buildings and the operating routines, and are in far better position to discover unsafe conditions and operating practices than the supervisor who is responsible for the safe conditions of the entire plant.

Although on his inspection tours, the supervisor may uncover many conditions that may be classified as hazardous, his good work is handicapped because,: (1) he cannot check the entire plant, and (2) he has only two eyes and though they may be very efficient at detecting unsafe conditions, their capacity is limited.

Hazards are too diversified for any one person in an organization to attempt to locate and apply the proper corrective measures. Buildings, machines, tools, materials, job performance methods and operating routines are capable of suddenly developing what might be termed "hazarditis." If properly trained and encouraged your employees can be developed into regular hazard reporters who are alert to unsafe conditions and see each one is reported.

One successful method of stimulating employees' interest in uncovering latent causes of accidents is the conducting of "Hazard Clean-Up Months." Such periods are specifically devoted to the discovery of dangerous conditions, and usually cause employees to become more alert to the safety of their every day surroundings, and as a result the benefits of such specialized activity continue long after the "Hazard Clean-Up Month" has ended.

Periods devoted to cleaning up the hazards are easily conducted. Like any other employee-participation program, interest can be increased through the offering of prizes to the employees reporting the greatest number of hazards. These prizes range from cash awards to safety shoes and goggles. Briefly the activities of a "Hazard Clean-Up Month" program are:

(1) Promotional material, such as bulletins, letters from operating officials and house organ articles list in detail the aims of the program, the rules, the real meaning of the term "hazardous conditions," and encourage employe participation.

(2) Forms for reporting unsafe conditions are provided all employees. These forms should be so prepared that the worker can easily describe the nature of the hazard, its locations, the employee's recommendations.

(3) A proper system of follow-up should be put into effect in the office responsible for safety activities. Every report should be immediately checked and the reported condition cleared. If employee-participation is to be received and sustained, all reports must be closely followed. Im-

proper follow-up seriously retards employee enthusiasm.

(4) A record should be maintained of all reports received. Recognition of the worker's interest as shown by his reports, should be made through a personal letter from the chief operating official.

(5) If prizes are offered, the names of the leading contestants should be posted weekly and competition encouraged.

A "Hazard Clean-Up" program built around those five suggestions should materially aid the reduction of any company's unsafe conditions. Perhaps to some executives a contest that results in the disclosure of a large number of unsafe conditions is a bad reflection upon the company. However, it should be remembered that the disgrace is not in the discovering of hazardous conditions—the real shame is in allowing them to exist until an accident reveals them.

There can be no exact dollar-and-cents value placed on the discovery of an unsafe condition, but the correction of an unsafe condition or an unsafe practice can be measured correctly as an accident prevented and the opportunity for a needless death or injury eliminated. If a hazard clean-up program prevents one accident the program has been worthwhile. Your plant may be so safe that perhaps the combined efforts of all of your employees may uncover a hazard no larger than a small nail left exposed for someone to step on or brush against but discovery of that one small nail is important.

Perhaps your plant does not need a "Hazard Clean-Up Month." Not so many months ago a busy superintendent told me that his plant was as safe "as a baby crib." Then we started looking around. It wasn't an extensive checkup; in fact we looked over only a few of the tools his employees were using daily.

We found screwdrivers with cracked and splintered handles and chipped blades, ladders with paraffin and solder spattered on the rails and rungs, extension ladders with frayed ropes, leaky rubber gloves, safety goggles with only one lens, hammers with loose handles—and before we had finished the super's so called "baby crib" wasn't the safe domicile it had been pictured. Why not make the same check yourself? It may cause you to take our hazard-cleanup suggestions to heart, and thereby start a program that will aid you in whipping the accident bugaboo of modern-day industry to a fare-thee-well.

CALCULATION OF TAPPED RESISTOR FOR VOLTAGE DIVIDER CIRCUIT

A COMMON application for tapped fixed or adjustable resistors in voltage divider or potentiometer circuits. These circuits are found in communications equipment, control devices, instruments and many other types of electrical equipment.

The method of calculation of a potentiometer or voltage divider circuit is best explained by means of a typical example. The circuit illustrated is for the assumed case of a voltage divider for a radio transmitter. Rectifier voltage (maximum across the divider) is 1000 v, taps are required at 750 v, 40 milliamperes, 500 v, 20 mils and bleeder current is to be 40 mils. Method: The first step is to make a sketch showing the voltages and currents. Commence with Section A, which carries only the bleeder current I_A. By Ohm's Law:

$$R_A = \frac{500}{0.040} = 12{,}500 \text{ ohms.}$$

$$W_A = 500 \times 0.040 = 20 \text{ watts.}$$

Section B carries the bleeder current I_A plus the current I_1 drawn at the 500 v tap or

$$I_B = 40 + 20 = 60 \text{ milliamperes}$$

$$R_B = \frac{250}{0.060} = 4{,}166 \text{ ohms.}$$

$$W_B = 250 \times 0.060 = 15 \text{ watts.}$$

Section C carries the current in Section B plus the current drawn at the 750 v tap.

$$I_C = I_B + I_2 \text{ or } I_C = 60 + 40 = 100 \text{ milliamps, or } 0.1 \text{ amp.}$$

$$R_C = \frac{250}{0.1} = 2{,}500 \text{ ohms.}$$

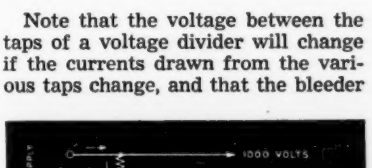
$$W_C = 250 \times 0.1 = 25 \text{ watts.}$$

$$R_{Total} = 12500 + 4166 + 2500 = 19{,}166 \text{ ohms.}$$

$$W_{Total} = 20 + 15 + 25 = 60 \text{ watts.}$$

Note that the voltage between the taps of a voltage divider will change if the currents drawn from the various taps change, and that the bleeder current section A) is increased under no-load conditions and is then equal to supply voltage divided by total bleeder resistance. All sections should be designed to carry the maximum current which would occur under the different conditions of use. In order to do this, each section is wound with the necessary size wire, there often being several sizes on one core.

From Ohmite News



Typical voltage divider circuit

ENGINEERING WILL PREVENT SMOKE, NOT FUEL-RESTRICTING LAWS, SAYS HOWE

IMPRACTICABILITY of attempting to abate smoke in industrial centers by passing ordinances restricting the type of fuel to be used in hand-fired stoves and furnaces was emphasized by R. E. Howe, Chairman of the Coal Producers Committee for Smoke Abatement at the recent Smoke Prevention Association of America convention at Toronto. "While there is no difference of opinion anywhere that I know of, that air purification is necessary there are two schools of thought on the best and most satisfactory way to arrive at this objective," Mr. Howe said.

"One school believes that it is only necessary to pass and enforce ordinances in the various localities which make it illegal to burn any solid fuel of over a certain volatile content say from 23 to 26 per cent," Mr. Howe continued.

"This belief is founded on two false premises. It presupposes first of all that there is an ample quantity of this low volatile coal available. This is open to serious debate.

"The second fallacy of the ordinance which would restrict hand-firing to low volatile coals is that the householder makes from 75 to 90 per cent of the smoke in any city. Cities which have taken comprehensive dustfall collections over a period of years show an almost identical difference between the heating and non-heating season of only 17 per cent. In any industrial city there are thousands of small commercial and industrial plants which use coal only for heating—they are not adding to the pollution during the summer months. So that we of the Coal Producers Committee for Smoke Abatement say that by no stretch of the imagination can the domestic consumer be charged with more than 8 to 10 per cent of the total air pollution in our cities today."

Mr. Howe explained that the second school of thought and the one advo-

cated by the Coal Producers Committee for Smoke Abatement is that any fuel will make smoke if not burned properly or that any fuel can be burned smokelessly. "It is all a question of combustion," he said.

It is no secret that only a ridiculously small number of cities have adequate smoke abatement departments today. A well-staffed and competent smoke department is necessary to supervise the installation and operation of fuel-burning equipment in the larger than domestic plants. Without this supervision new plants will be improperly installed as fast as older plants can be corrected of their smoke troubles. Do not let today's installation become tomorrow's smoker," Mr. Howe concluded.

LETTERS AND COMMENTS

ENGINEERS IN CLEVELAND ARE LUCKY

Editor's Note: Engineers in Cleveland, Ohio, are lucky to be able to take a course such as Mr. Ladd describes. As he points out, it is available not only to members of the union but is open to anyone engaged in power plant work or allied fields. The subjects covered in this course are shown in the tabulation and the text books used are listed below.

I WOULD like to add a few words along the lines of the letter by Mr. T. F. Cunningham which appeared in the May issue of POWER PLANT ENGINEERING.

Here in Cleveland we have a school for anyone in power plant work. It is sponsored by local 589 of the International Union of Operating Engineers with the local Board of Education. The course is not limited to members of the Union, but, is open to anyone in power plant work. The instructors, of which there are four, are all college graduates and professional engineers. (2 mechanical—1 electrical—1 civil). From the enclosed schedule and list of text books it can readily be seen that it is no mere question and answer school.

It has been my experience that the professional engineer is glad to give all the help he can to a man who wants to learn more about his trade. It seems to be the one who doesn't know the answers who always "blows his top" when asked 'why or how'.

An engineer needs to study just as much as a doctor or he will not be able to diagnose the ailments in his plant. He must keep up with the latest developments unless he is only interested in hard work without efficiency. Our natural resources are dwindling and they must be conserved. The engineer who can show his employer how to produce the same amount of work from less fuel is not 'polishing apples' but is doing what he should consider his job just as much as checking the oil flow to a bearing.

I agree most heartily with T. F. C. that the "buying and ordering of repairs" belongs to the man in the engine room and not to anyone else provided he has the "know-how". He can get that in only one way, by STUDY and plenty of it. Yes indeed we need every bit of education we can get if we want to be able to hold our heads up and look the other fellow in the eye and say we are ENGINEERS.

Cleveland, Ohio H. K. LADD

TEXT BOOKS USED IN THIS COURSE

(1) STEAM PLANT OPERATION — WOODRUFF & LAMMERS.
(2) ELEMENTARY STEAM POWER ENGINEERING—MacNAUGHTON.
(3) ELEMENTS OF INDUSTRIAL HEAT —RANDALL & GILLAN.
(4) REFRIGERATION DATA BOOK— AMERICAN SOCIETY OF REFRIGERATION ENGINEERS.
(5) HEATING & AIR CONDITIONING— ALLEN, WALKER & JAMES.
(6) KENT'S MECHANICAL ENGINEER'S HANDBOOK (POWER)—R. T. KENT.
(7) BARLOW'S TABLES (SQUARES, CUBES, ROOTS AND RECIPROCALS.)— L. J. COMRIE.
(8) DR. BRUHN'S SEVEN FIGURE LOG. TABLES.
(9) MATH. TABLES FROM HANDBOOK OF CHEMISTRY & PHYSICS.
(10) THERMODYNAMIC PROPERTIES OF STEAM (WITH MOLLIER DIAGRAM) —KEENAN & KEYES.
(11) THERMODYNAMIC CHARTS — ELLENWOOD & MACKEY.
(12) 270 DATA SHEETS PREPARED BY INSTRUCTORS SUPPLEMENTING THE ABOVE SUBJECTS.
(13) PROPERTIES OF AMMONIA— U. S. BUREAU OF STANDARDS.
NOTE—ITEMS 6, 7, 8 ARE OPTIONAL, ALL OTHERS ARE REQUIRED.

THE OLD ENGINES RUN ON

Editor's Note: Some time ago during correspondence on other matters, Mr. Campbell mentioned the fact that there were a number of old engines running in and around Jamestown, N. Y. We suggested that he get pictures of some of them and tell us a little about their history; we felt that they would be of interest to other readers, particularly those who grew up with the old Corliss engine. Mr. Campbell's letter appears below together with the photographs. As he points out it is impossible to get good pictures in many of these old plants because of cramped quarters; he did the best he could.

HERE ARE THE PHOTOGRAPHS of the old engines still in operation here in Jamestown. Some of the pictures do not suit me but the engine rooms were built just big enough to go around the engine so it was impossible to get far enough away from the machines to get good pictures.

Figure 1—This little fellow is a 12 by 12 Skinner Engine—running at 265 rpm and still turning a line shaft at The Elite Furniture Co., Jamestown, N. Y. It was installed brand new in 1915 and according to the Mr. Alfred Carlson its one and only engineer in all that time, has never been shut down during working hours. This, in my opinion, speaks very well for both the engine and Mr. Carlson. (I wanted Mr. Carlson to get in the picture, but he said he didn't want to spoil a good engine.)

Figure 2—This yours truly and "Old Maria" otherwise known as Harris-Corliss Cross Compound-18 by 32 by 48-running at 70 rpm. In the old days

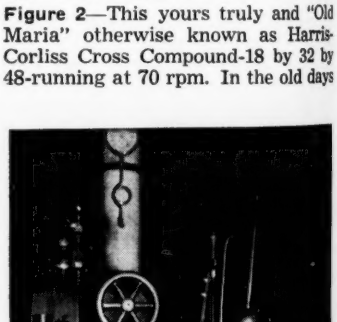


Fig. 1

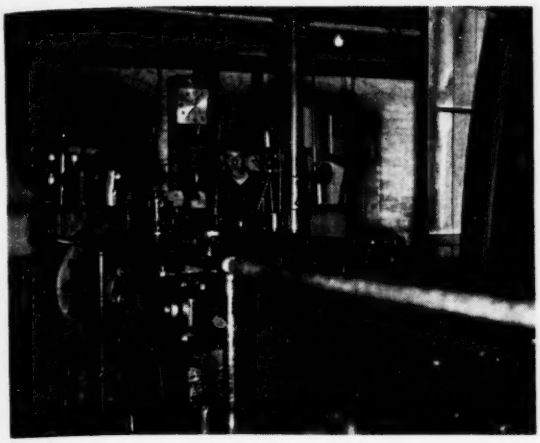


Fig. 2

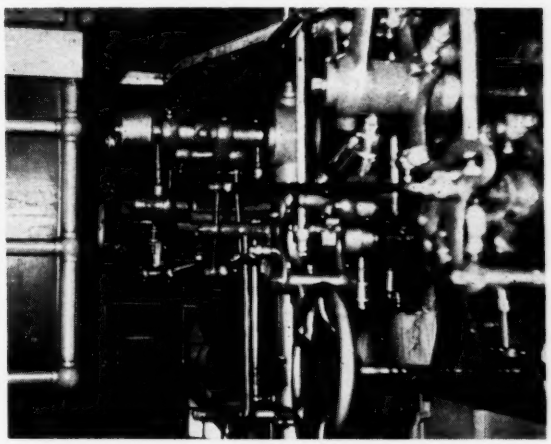


Fig. 3

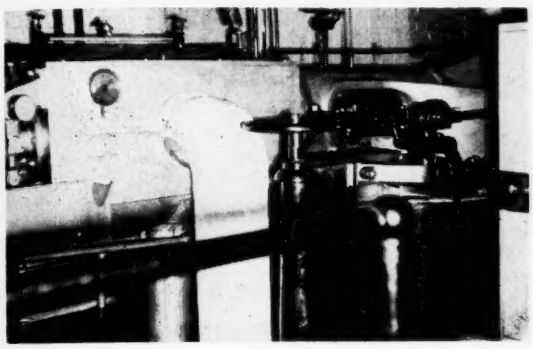


Fig. 4

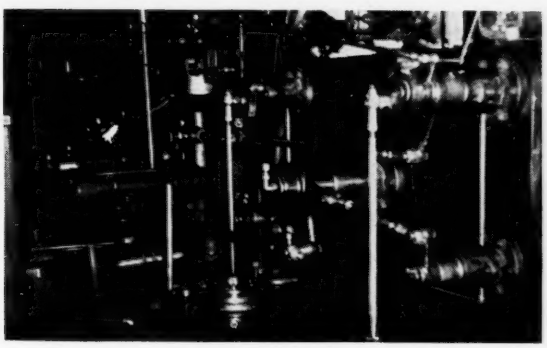


Fig. 5

she turned a line shaft but at present is loafing along with a 200 kva generator hitched on. The engine was running when this was taken. This engine is well over 50 years old. It was installed in its present location, The Empire Worsted Mills, in 1910—being second hand at that time.

Figure 3—This baby is a 16 by 36-Nordberg running at 117 rpm pulling a 200 kva generator in The Empire Core Goods, Jamestown, N. Y. It was installed brand new at its present location in 1913 and still pounding along.

Figure 4—This is a 11 by 24 by 24-Tandem Compound Buckeye. Running at 163 rpm and direct connected to a 150 kva generator. It was installed in its present location the Watson Manufacturing Co. brand new in 1910 and still running merrily along.

Figure 5—This is a 20 by 42 Corliss Engine Manufactured by the Allis-Chalmers Co. and turning at 105 rpm. It was installed at its present location The American Manufacturing Co. in Falconer (a small town about 2 miles from Jamestown). It is still pulling a line shaft believe it or not. It was installed brand new in 1914 and is still knocking 'em off.

It's anybody's guess just how long any of these engines will continue to run, but they are all running at present so why worry about tomorrow.

Because we still have so many of these old relics around, does not mean that we live in a backward town. We have one of the finest Municipally owned Electric light plants in the country and at present they are working on a $4,000,000 expansion program which includes a 20,000-kw generator.

I'd like to say a little more about our plant. Besides taking care of the engine I also have a lot of pumps and a filtering system to take care of. As a Worsted mill uses a lot of water for process work. I have two Worthington 7½ by 7 by 10 that were installed in 1901. The filtering system was installed in 1901—I also have a big single plunger pump made by the old Snow Co. and used on Noah's Ark. It has—7″ steam bore—12″ water and 15″ stroke. I also have a few Centrifugal pumps. This old equipment sure gets in your hair at times, but after all if you never have any trouble you never learn anything. I've always taken a little pride in keeping things moving every day, even if it mean't going down to the plant on my own time and doing repair work.

We do have a nice boiler, a 500 hp water tube boiler operating at 200 per cent rating. About a year ago we installed a Fyre Feeder over the fire stoker and just recently they put in a Hayes Automatic Combustion control and they sure work fine. It sure is a far cry from the days when you took a No. 10 scoop shovel and you had an old hrt boiler with stationary grates and tried to keep that old steam gage from bearing to the left too much.

Jamestown, N. Y. JAMES CAMPBELL

METAPHYSICS AND THE PHYSICAL SCIENCES

THERE IS PRINTED in the September issue a letter concerning the relation of meta-physical and physical sciences, page 95, and to attempt to even scratch the surface of such a subject would require volumes assuming the various angles and implications are discussed.

The question is a natural one but at once poses the relation of the REAL and IDEAL; to quote: "Life is real, and life is earnest, and the grave is not its goal,—"

Meta-physics to most of us bears on religious and philosophical subjects and their study in the broadest sense. Engineering and associated effort deal with things actually known about or at least demonstrated in a physical way, meta-physical studies are based upon fundamental things, most of them beliefs handed down or taught as fundamental doctrines with no definite physical reality.

Religion and education should go hand-in-hand as they are both intended to elevate the mind and their

relation must of necessity be a matter of individual choice and selection.

Psychology is not a neglected science in a practical sense and is applied in everyday life whether instinctively or otherwise. The presentation of any project discussion and particularly the approach of the practical politician, trade politician if you will, are examples. The physician treats a patient through the prescription of some harmless pill and so on through every walk of life.

The "graduate engineer" has merely fundamentals, tools, as a foundation upon which must be erected the structure of acocmplishment.

The education of the child is always one of difficult approach and years ago the so-called Gary system was one of the suggestions, long since supplemented by others.

The advance and progress of science was for many centuries limited to the sphere of meta-physicians and we now know many apparently mysterious demonstrations were merely the application of normal natural methods used by the group "in the know" to impress the illiterate and the essentially ignorant rank and file for certain definite reasons. All these elements are noted when one lives in more primitively populated areas.

There is still too much restraint in attempting to limit mental growth through group inhibitions or by stating: "It's not nice to do" or "it must not be read since it creates dangerous thoughts." The very fact that many cannot ever make up their own minds or make their own decisions is indicated in the trends toward mass group control tending toward totalitarian methods, we have witnessed so much of during the past fifteen years.

The libraries are full of all types of books and perhaps Drummonds "Natural Law in the Spiritual World" may be a good one to start with.

But when all is said and done Newton's laws of motion, particularly that referring to action and reaction, are basically fundamental and postulates which can with modification be applied to everything in life.

C. O. VON DANNENBERG

Brooklyn, N. Y.

A BOILER HOUSE TRAGEDY

By John Q. Raven

I'M NEUTRAL myself, but I wonder if any power plant operators have ever seen those oversize gray things with the long tails, maul a plant pussy. The fanciful outcome of this "tragedy" is quite possible, considering the extensive marks of battle I have seen from time to time on the meowing type of rat trap, returning with the kill. Here's the rhyme.

We saw the cat scorn Jesse the Gent,
Lifting his tail in the vulgarest way,
To show the height of the scorn he meant
While classing Jesse as lesser clay.
And though hate flamed in Jesse's eye
We never guessed the cat must die.

For Jesse fathered a secret oath,
Knowing the Chief, Greaseball and me
Were Jo-jo's friends, nor loathe
To call the cat, more gentleman than he.
No poisoned meat, no shot, no throttled breath
Would do. He planned more subtle death.

So Jesse schemed. "This Jo-jo is a bum,"
He cried. "The rats make picnic with my lunch,
While Jo-jo sleeps behind some boiler drum
Indifferent to their fun. I've got a hunch
A rat could beat him in fair fight.
Let's make him earn his keep—tonight."

Then spoke the Chief: "Before you came
We had no rats." Nor minded Jesse's scowl.
"My money's on the cat." Old Greaseball said the same
And me. Then Jesse grinned, so dark and foul
I felt a chill. "To blood and money," Jesse said,
And made mock toast with tilted head.

Next Jesse caught a rat, from Hell's own brood.
The powder from a shotgun shell
He used each day to spice the brute's raw food
Until no fiend could be more fell.
Mysteriously, the cat kept out of sight
And Jesse crowed: "He's run away in fright."

But darkly Greaseball told: "Three nights a cat
Has howled in Jesse's house. And yet
He has no cat. What does it mean?" Right after that
Jo-jo came back, and met
Us like a refugee from Hell, Dull-eyed,
His ribs like broken staves, he licked my hand, and cried.

Jesse quickly got his rat. "We now will
See who can whip who." We waved him back,
"Let's wait and keep it fair. The cat's too ill
Today." But Jesse's hate was ebon black—
"He'll fight right now, or else." And speaking thus
He loosed his fiend on Jo-jo and on us.

Weakly Jo-jo arched and growled. The evil beast
Gave thought and stopped. Then squeaking hate
He sidled round the cat. As to a feast
Familiar Jo-jo sprang, and missed. Too late
On failing limbs, the rat's teeth mated in his throat.
Soon Jesse smugly spoke. "I've won," he said. "Please note."

Thus Jo-jo died. He had no chance,
But bravely joined the nameless and the great.
No more we'll see his friendly glance
Lift to us from his dinner plate.
But in his grave, we laid his tail full high—
This gentleman, who showed rats how to die.

Questions And Answers

Question No. 398

HOW CONTROL OIL BURNERS ON VARYING LOAD?

1. What provision is made or what is necessary to operate a rotary cup type oil burner on a varying load? Or what adjustments are necessary?

2. How does a steam atomizing oil burner take care of a varying load?

3. How does a mechanical type oil burner take care of a varying load?

J. W. BURNS

Question No. 399

SHOULD 115-V EXTENSION LIGHTS BE USED INSIDE BOILER DRUMS?

CAN YOU TELL me whether or not there is any article in any of the National Safety Codes or in the ASME Boiler Code that specifically states the maximum voltage permitted on extension lights for use inside boiler drums and other damp or wet places in a boiler, during inspection or repairs?

I have always used 30 to 32 v for such internal inspections and would never recommend a higher voltage. Our electrical engineers, however, are recommending 115 v for this purpose in a new boiler plant we are about to install. But I am insisting on the lower voltage.

If there are no specific provisions covering this point in any of the codes, what is considered good practice? It seems to me this voltage for extension lights might also be related

to the permissible voltage on any electric-driven tools that must be used inside a boiler drum or into any other wet place in a boiler. Comments from readers on what they do in such cases will be greatly appreciated.

Mexico R. H. N.

Question No. 400

CAN OPERATORS SIT DOWN BETWEEN ROUNDS?

HAVE ANY tests been made on plant personnel to find if they were more or less attentive to their duties when allowed to sit down to their log desks or control stations. It is understood that they would not remain seated all their watch but allowed to sit down between rounds whenever nothing important was taking place.

LOUIS E. SAYRE

West Palm Beach, Florida

Answer No. 392

HOW SHOULD HE LINE HOT-WATER STORAGE TANK

I HAVE HAD 25 years as a plant engineer and have tried all kinds of ways and means of preserving the inside of boilers, hot water supply tanks, cold water for drinking purposes and will say that the most satisfactory method is to give the tanks, boilers, tubes, and any kind of storage vessel a coat or two of Apexior No. 1 for boilers or hot water tanks, and Apexior No. 3 for cold water tank interiors.

I have used Apexior for several years and it does a good job.

Decatur, Ga. J. G. DOZIER

Answer No. 387

HOW CALCULATE SIZE OF FILLING AND EQUALIZING PIPES

IN ORDER to calculate the flow of water or other liquids through a pipe system it is necessary to calculate the resistance of the system to the desired flow and make the size of the line such that its resistance is less than the force or head available for creating flow.

The method of calculation is given in detail in various text books on hydraulics. For short lines with water at ordinary temperatures, the matter of viscosity can ordinarily be ignored.

First determine the head available which in this case may be obtained as follows:

Vertical distance center to center tanks	11' - 2"
Center line to bottom of treatment tank	4' - 0"
Center line to top of Rueping tank	4' - 0"
Maximum head	19' - 2"

As the treatment tank fills the liquid level in the Rueping tank falls and in the treatment it rises, the rate of change being different in the two tanks because of the loading in the treatment tank, which will be assumed as 75 per cent of the volume of the tank. Then when the treatment tank is filled the liquid will be down about 2 ft 5 in. in the Rueping tank.

The minimum head will then be as follows:

Rise in treatment tank	8' - 0"
Drop in Rueping tank	2' - 5"
Total change	10' - 5"
Maximum	19' - 2"
Less change	10' - 5"
Minimum head	8' - 9"

Average maximum plus minimum divided by 2 or

$$\frac{19' - 2" + 8' - 9"}{2}$$

$= 13' - 11\frac{1}{2}"$

Say 14' (this is only approximately).

The volume to be handled would be in this case one-fourth the capacity of the tank or 9400 gal and the rate of flow would average 940 gpm.

Looking into a convenient book of tables we find the velocity for this rate of flow through an 8 in. standard steel pipe would be approximately 6 fps, which will require a head of 0.56 ft to produce. This is known as Velocity Head and is part of the resistance.

Then there is a further loss known as the Entrance Head, which varies greatly with the shape of the entrance. For a square edge entrance, at a velocity of 6 fps this amounts to 0.28 ft.

The resistance of the pipe is determined by its length and velocity, which is 2.74 ft per 100 ft of straight pipe.

Each valve and turn or fitting increases the resistance, the resistance for each of these items being computed in terms of straight pipe. The loss for an 8 in. gate valve as given by Crane tables is equal to 3.75 ft of pipe. Loss for a 45 deg ell is 10 ft. Loss for a tee is 45 ft. Assuming 15 ft of pipe, one gate valve, one tee and one 45 deg ell we have an equivalent line length of $15+3.75+45+10 = 73.75$ ft. The line loss is then $\frac{73.25}{100} \times 2.74 = 2.02$ ft. To this must be added the entrance loss and the velocity head loss or 0.84 ft, $2.02+.84=2.86$ ft total loss for an 8 in. pipe. For a 6 in. line the loss would be as follows:

Velocity 10.5 fps
Friction head per 100 ft of straight pipe 10.2 ft
Velocity head 1.7 ft
Entrance head 0.81
Gate valve = 5.2 ft of pipe
45 deg ell 7.5 ft of pipe
Tee 34.0 ft of pipe
Line loss then is
$15+5.2+7.5+34=61.7$

$\frac{61.7}{100} \times 10.2 = 6.29$ ft head loss in line.

Adding Velocity (1.7 ft) and Entrance (0.81 ft) or 2.51 ft to 6.29 ft we have a total loss of 8.8 ft as against a minimum head of 8.75 ft. So an 8 in. pipe would be the most certain bet though the 6 in. might do. The time required to empty the Rueping tank through an 8 in. diameter orifice will vary considerably with the details of the opening, the valve, the length of nipple, etc., but for a square edge orifice it would be reasonable to assume a coefficient of about .6 and that the velocity will vary from 4.8 fps for 1 ft depth to 13.6 ft for 8 ft depth or an average of approximately 9.8 fps, equivalent to 1527 gpm. $37600 \div 1527 = 24.6$ minutes. However, the actual time may be much less or much more, depending upon the details. I. A. B.

Answer No. 392

WILL INCREASING PUMP SPEED GIVE NEEDED CAPACITY AND HEAD?

George Says No

MY ANSWER is NO; better junk the pump.

From the data given, the pump must certainly be an antique since the name plate is missing. When it was new it delivered 500 gpm when operating at 1750 rpm. Now when it is ready for the junk pile the owners want more water.

They state that the pump seems to be in good mechanical condition, runs quietly, no gland leakage. I just wonder what the inside of the pump looks like. The owners may be surprised if they lift the cover.

Who ever heard of operating a centrifugal pump without allowing the glands to leak a little? This leakage shows that the lantern glands are operating; and at the same time it cools the packing. Water is just about the cheapest lubricant we now have.

I might also state that the total head of a pump varies as the square of the speed and at the same time the capacity varies directly as the first power of the speed.

I think Mr. M. K. would profit if he would purchase a new pump to suit his operating conditions.

GEORGE G. AVANT

Wilmington, N. C.

Larger Impeller Will Increase Rate of Pump

IT IS possible that a pump built to deliver 500 gpm at 1750 rpm can be made to deliver 600 gpm at the same delivery head by installing a new impeller of large diameter. The manufacturer of the pump should be consulted for information on this matter.

The original delivery head was not stated in the question. If the original delivery head was 135 ft or more, the possibility of making the change would appear favorable.

An item which is frequently overlooked in old pumps is the one of efficiency, the efficiency of most present day centrifugal pumps being approximately 10 per cent or more higher than the efficiency of similar pumps built fifteen years or so ago. This should be checked against power

costs before deciding to use the old pump as is or changed.

The matter of whether changes would be required in the piping system can only be intelligently answered by studying the present piping system though it is safe to say that if the present system is economically sized for the volume now being handled, then it certainly would be too small to handle 600 gpm. While investigating the piping system it is very important that the suction line receive attention too.

Piney River, Va. IRA A. BUTCHER

Comments by Osborne

I ASSUME that the pump has 4 in. suction and 3 in. discharge openings and the impeller is about 12½ to 13 in. in diameter. Based on the above, when the pump, at the present speed of 1150 rpm is delivering 235 gallons at 75 ft total head, the efficiency is about 70 per cent, and the pump requires approximately 6 bhp, therefore, the present 30 hp motor is entirely too large.

If M. K. speeds the pump up to 1750 rpm, it will deliver approximately 600 gpm at 135 ft total head. The efficiency would be 75 per cent and the pump would require 27.2 bhp and should be driven by a 30 hp motor operating at 1750 rpm.

In reference to present piping, it is possible that the size should be increased to at least 6 in. However, that depends on the actual length of the delivery pipe.

For 235 gpm passing through a 4 in. pipe, the friction is 6 ft per 100 ft of pipe and for 600 gallons in a 4 in. pipe, the friction would be 32.5 ft per 100 ft of pipe. This latter figure is entirely too high, therefore, the pipe should be at least 6 in.

If M. K. would give the size of the pump and the present diameter of the impeller, it would be much better, and greater accuracy could be obtained in figuring out his proposition.

Seattle, Wash. JAMES Q. OSBORNE

Cut Underside of Vanes to Increase Capacity

THE DATA GIVEN by M. K. is insufficient to permit a simple unqualified answer but the solution to his problem can be determined.

When the original operating speed of the pump was reduced from 1750 rpm to 1150 rpm it apparently was accomplished by using a 6 pole motor of the same hp as the 4 pole motor it replaced. This is a reasonable assumption since only 7½ hp motor, or 10 hp at most, would be required to drive the unit at 1150 rpm and deliver 235 gpm against 70 ft total head; and further, the present head capacity conditions indicate that for 1750 rpm operation the pump would need a 30 hp motor.

Whether the existing pump will deliver 600 gpm against 135 ft head at 1750 rpm is problematical. This can be roughly determined, however, by a simple test with the present 1150 rpm motor. Since the capacity of a centrifugal pump varies directly as the change in speed and the head varies as the square of the speed change, the approximate performance at 1750 rpm can be calculated from test at 1150 rpm.

In order to deliver 600 gpm against 135 ft head at 1750 rpm the pump must produce 394 gpm against 58 ft head when operating at 1150 rpm. This is calculated as follows:

$$\frac{1150 \text{ rpm}}{1750 \text{ rpm}} \times 600 \text{ gpm} = 394 \text{ gpm}$$

$$\left(\frac{1150 \text{ rpm}}{1750 \text{ rpm}}\right)^2 \times 135 \text{ ft} = 58 \text{ ft head}$$

Assuming that the required head at 1750 rpm is fixed at 135 ft the test at 1150 rpm must be conducted with the pump developing 58 ft total head and the capacity at this head measured. Then the capacity at 1750 rpm and 135 ft head may be calculated as follows:

$$\text{gpm @ 1750 rpm} = \frac{1750 \text{ rpm}}{1150 \text{ rpm}} \times \text{gpm @ 1150 rpm}$$

If the computed gpm at 1750 rpm is insufficient there are two possible ways of obtaining more capacity from the present pump. Additional capacity can be obtained by increasing the pipe size of the system piping so as to decrease the system-head. This, of course, is an expensive method unless an unusually short system of piping is involved.

A much cheaper and convenient procedure is to make a change in the impeller, provided the additional capacity expected is not too great. This can be done by chipping and filing the under side of the vanes as shown in Fig. 1. If the vanes are quite thin this method cannot be used.

If neither of the above procedures are practical for M. K.'s pump, he had best contact the pump manufacturer giving complete details and the manufacturer may be able to supply a wider impeller for the new conditions of service.

Holyoke, Mass. P. J. EQUI

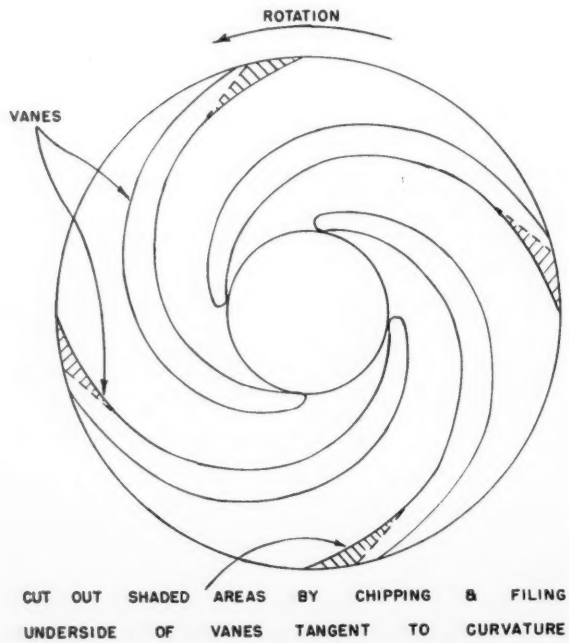


Fig. 1. P. J. Equi states that cutting the vanes as shown will increase pump capacity

Answer No. 394

PREPARING SCOTCH BOILER FOR OPERATION

THE FIRST thing that T. S. should do is check the entire boiler and see what care was given to it before shutting it down. Go over it internally and externally, check the furnace drum, crown sheet, and stays and stay bolts.

Make sure the water side of the boiler is clean, check fusible plug. If after finding everything OK and furnace and the boiler are cleaned, then the boiler inspector can be called so he can make his check. The boiler inspector would insist on a hydrostatic test after this boiler being down for the length of time that it was. If the inspector finds that everything about the boiler is safe for putting on the line, then T. S. can go ahead and close up the boiler after making sure that there aren't any tools or material left in the boiler. See that the blowoff valves are closed, air cock open (if there should be one) valves to steam gage open. Also, be sure feedwater valves to boiler are open. Knowing that everything is ready the boiler is filled to the proper level. Then a light fire is put in the boiler furnace. It is carried this way for several hours to make sure of equal expansion throughout the entire boiler setting. After there is a

pressure of 10 psi on the boiler, it would be a good practice to open up the boiler stop valves slowly and in this manner it would give a chance to check the entire steam line and show up the leaks if there should be any.

After T. S. has run his boilers for several hours with a low flame, he can gradually increase the fuel supply so as to increase the flame. Many operations will be done to get the boiler on the line especially if T. S. has sufficient time to carry these out without hurry.

Philadelphia, Pa. W. T. MULLEN

If Unused for Long, Wash with Caustic

THE AMOUNT of work required to get this boiler ready for service depends a great deal on how the boiler was laid up in the first place. If the boiler was properly laid up, it will probably be full of strong lime water. It will have been previously cleaned and all necessary repairs will have been completed before laying up. In this case, there will not be much to do. Simply drain the boiler, open it up and wash it down good and have it inspected. If there should be any repairs necessary, have them completed and then put a hydrostatic test on it. After that, start a slow fire in the furnaces until the unit is properly warmed up. Then proceed as any other fire-tube boiler.

However, if the boiler has NOT been properly cared for during its idle period, there may be much to do and it is a chance that the metal has deteriorated enough to warrant condemnation from the inspector. To proceed to convert this boiler back to service, first drain the boiler if there is any water in it and open it up. Thoroughly clean the boiler inside and out. All accessible parts should be scraped to the metal. All loose material washed out. An inspection should be made for loose braces, corroded or loose rivets or corroded or pitted areas. The furnaces should be inspected for cracks in the corrugations and around the end seams. All manhole and handhole covers, yokes, studs, and nuts should be inspected for cracks or corrosion and repairs or replacements made where necessary. The tubes should be inspected for pits or corrosion. The water column and gage glass valves should be removed and inspected and the connections to the boiler cleaned out. The try cocks should be repaired or replaced with new ones. All connections to the boiler, such as flanges for feedwater pipe, water column, blow-off piping, main steam valves, safety valves, etc. should be inspected for cracks or loose rivets. In the case of screwed connections, the pipes should be unscrewed and the threads inspected on both the pipe and in the hole. The pipes should be inspected for deterioration.

All of the oil burner equipment should be taken apart and thoroughly cleaned and inspected. These would be: burners, strainers, pumps, valves, heaters, tanks and anything else connected to the burner equipment. All parts should be repaired or replaced with new ones where needed.

All of the valves on the boiler should be taken off such as the main stop, non-return, feedwater valves, blow-off valves and any others, cleaned, ground to new seats or replaced where necessary. The feedwater regulator, if there is one, should be taken off and thoroughly gone over.

If the feed pump is part of the unit, it should be taken apart and overhauled, repaired, cleaned and put back.

The fusible plug should be replaced.

The steam gage should be thoroughly tested or replaced.

After all of the above work has been completed, the boiler should be closed up, filled with water to the operating level and a strong solution of caustic soda put in and a slow fire put in the furnace. This is preferably of wood. The solution in the boiler should be boiled for about 3 hr, leaving the top manhole cover off. After the boiling period is over, allow the fire to die out and the boiler to cool. Drain and wash out thoroughly.

At this time the inspector should be called in and he will thoroughly inspect the boiler. After all of his recommendations or orders have been carried out, the boiler is again closed up and filled with water and hydrostatic test applied. The boiler is then gone over very carefully for leaks or cracks paying particular attention to the furnace end seams. If no leaks are found, the boiler is ready for putting into service. If leaks are found, they must be repaired and another test supplied. After this test is over, lower the water to the operating level and light off with a light fire. The boiler is gradually brought up to pressure. The cutting in is the same as for any other boiler. If a non-return valve is on the boiler, the main stop may be opened before the line pressure is reached and the boiler will cut itself in. If no non-return valve is used, bring the pressure up to line pressure and then open the main stop valve and the boiler is in service. After this the fires are brought up to full height.

During the time while all of the inspection work and repairs are being made to the boiler, attention should be paid to the items outside of the boiler itself. These are the breeching, dampers, base or foundation, stack and any other items that are either directly or indirectly concerned with the boiler.

Baltimore, Md. Chas. W. Parks

Answer No. 399

WHAT FLOOR PAINT WILL RESIST CREOSOTE?

There are two points to take into consideration, (1) to prevent the creosote from leaking onto the floor, (2) how to eliminate it if it should get on the floor.

E. L. B. mentions the gasket blowing. When this happens there must be excessive pressure to cause the gasket to blow, or, the packing material that the gasket is made from isnt the proper type to resist the creosote.

So the first problem would be to check the pressure in the piece of machinery that is blowing the gaskets, if this pressure is too great it means that the pressure is to be reduced, if this can't be done then a relief valve can be installed so that the pressure will be released.

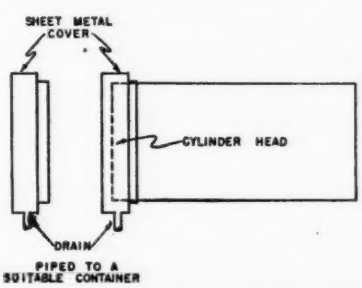
The relief valve can be installed in such a manner that the valve is piped and what creosote is blown out through the relief valve can be saved by blowing it into a suitable drum or container.

Secondly, the gasket material can be changed so that the gasket will stand up under a higher pressure while running this creosote. There are many packing concerns who would be glad to supply the information that E. L. B. would need.

Glad to hear of E. L. B. trying to install good housekeeping in his plant, there are many other plants throughout this country who could follow suit and stop being "penny wise and dollar foolish."

As for the color of paint to use on motors, pumps, piping and tanks. This is another check to make if a light paint is used and there is much dust and grime gathering over a short period of time, it may look worse than with a darker shade of paint.

The size of the retort house, the amount of light that it gets from the sun (daylight period), whether the paint is bought or made in the shop, also the type of lighting system—would all have a bearing on the paint to be used. What might be a good shade in one plant would be a poor type in another plant. I would take this question to a reliable paint manufacturer.



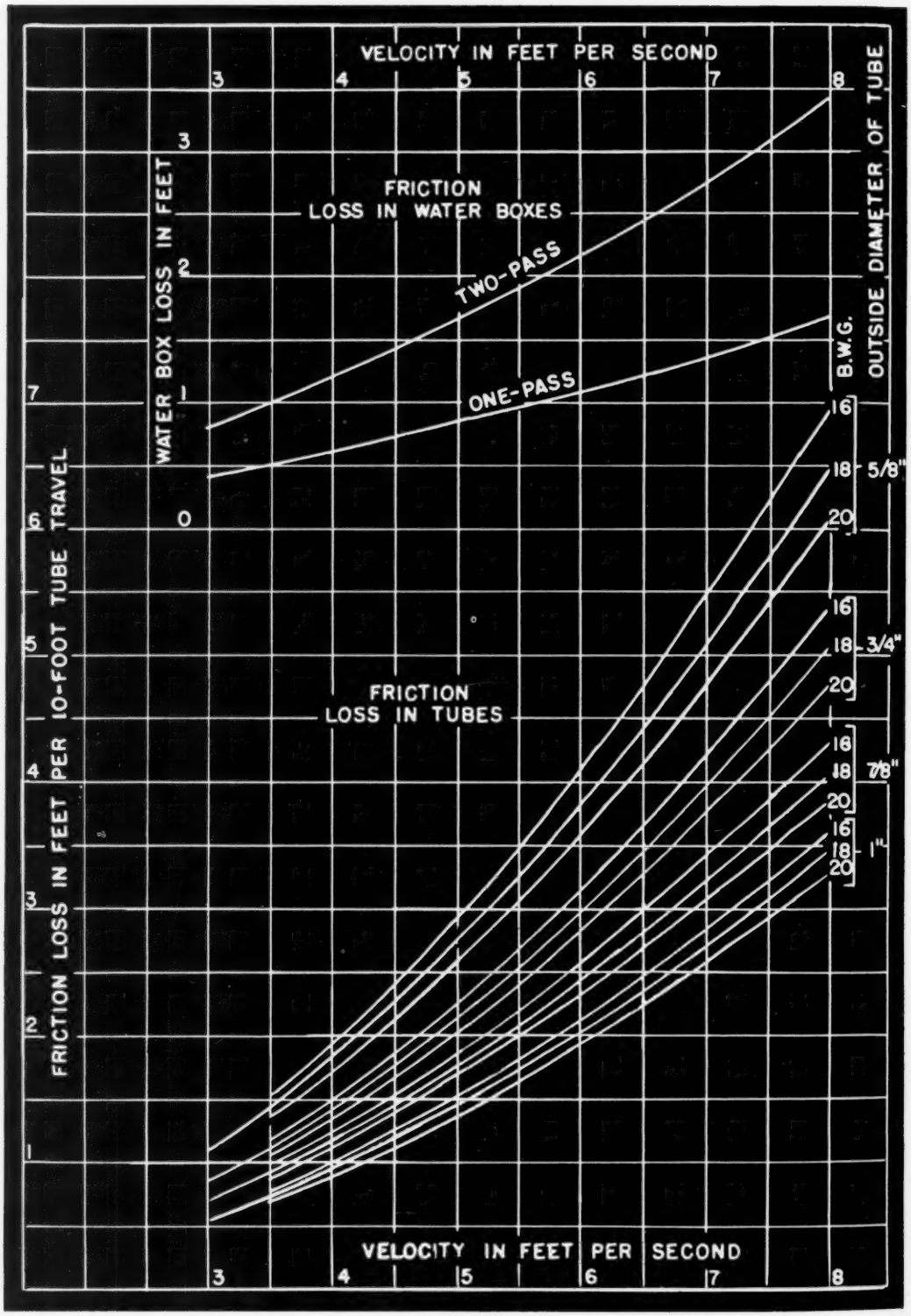
The metal cover fits over the cylinder head and is secured with machine screws. Fit with a suitable drain to a container to indicate a leaky or blown gasket at anytime

If the relief valve or the gasket material isn't suitable to E. L. B. a sketch is enclosed of what he can do to keep the creosote off his floor.

William T. Mullen

Philadelphia, Pa.

Condenser Tube Friction Loss Chart



Friction loss through condenser tubes is a direct function of water velocity. To the loss in the tubes, however, must be added the head loss in the water boxes and loss due to entry and exit in the tubes. This chart, reprinted from "Surface Condensers," published by the Elliott Co., gives values of losses for clean tubes. The upper curves, covering losses in water boxes, take into consideration the entrance and exit losses from the tubes

ATOMICS

A New Section added to POWER PLANT ENGINEERING to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

Radioactive Isotopes as Tracers

Sources of radioactive isotopes . . . Use of isotopes in steel analysis . . . Control of coating thickness in manufacture of Rayon fiber . . . Classification of tracer methods . . . Tracer methods involving location of things . . . Radioactive indicators in oil pipe line operation . . . Measurement of odd shapes . . . Measuring pipe wall thickness . . . Detection of gas leakage . . . Use of Radioactive Isotopes in friction studies

By **ANDREW W. KRAMER** *Managing Editor, Power Plant Engineering*

THE GREAT VALUE of radioactive isotopes as tracers, lies in the extreme delicacy in which their presence can be detected. By the use of the Geiger-Muller counter, it is possible actually to detect single atoms.

In recent years many interesting and valuable applications of radioactive isotopes have been made in biological and in industrial fields. Unfortunately many of the latter class have been made as a result of private research by commercial organizations, and have not been disclosed to the general public. Consequently, no mention can be made of these.

All of these private researches have been made with radioactive isotopes produced by means of cyclotrons and other accelerating devices. At the present time, radioactive isotopes are available from the Atomic Energy Commission at Oak Ridge, Tennessee, and it is part of the purchase agreement that anyone, individual or organization, obtaining isotopes from this source, must publish or otherwise make available to the general public, the results of research or work carried on by means of these isotopes. This is an admirable provision of the agreement governing the sale of these isotopes.[1]

Despite the fact that some of the more interesting applications of isotope tracers cannot be described, there are a number of which *can* be described, and these will serve to indicate the nature of the methods used as well as their value.

The following example, described by Aten and Heyn[2] show typical industrial applications.

In the production of steel, among other substances the phosphorus, which is present in quite considerable quantities in the crude iron, has to be rendered harmless by adding a slag-forming substance or by lining the crucible with a material which reacts to phosphorus. A continuous check has then to be kept of the amount of phosphorus still present in the molten metal. This can, of course, be done by chemical analysis of samples, but results are obtained much more quickly and easily when a small amount of radioactive phosphorus is added to the melt at the beginning of the process. This is rapidly distributed uniformly throughout the melt, so that the ratio between the natural phosphorus present and the radioactive phosphorus added is the same everywhere. If the phosphorus disappears from the melt into the slag floating on the surface or into the lining of the crucible this takes place to an equal degree with the natural and with the radioactive element. The decrease in the percentage of phosphorus in the melt can thus be determined merely by ascertaining the decrease in the radioactive phosphorus. This is extremely simple, since it is only necessary to measure the radioactivity of a sample of the melt.

Coating Rayon Fiber

Another interesting use of tracers is one that was developed in the rayon industry, in applying the finish coating on rayon fibers. In the manufacture of rayon yarn, it has been found necessary to coat the rayon fiber with a thin coating of sodium maleate. This is beneficial both in the weaving processes and in the dying operation. The coating operation, however, requires a delicacy of control that is unusual, since the rayon fiber is only 4 mils in diameter and a mile length only weighs 1 ounce. When it is considered that the sodium maleate involved weighs less than 2 per cent of the total, it is obvious that the amount is exceedingly small and that the coating process is difficult to control.

By mixing radioactive sodium with the sodium maleate solution, however, it is possible, accurately, to measure the effectiveness of the coating; indeed, it is possible to measure the sodium maleate coating on a length of 1 millimeter of yarn with an accuracy of 2 per cent!

This process has another value in

[1] For information regarding the purchase of isotopes, communicate with Dr. Paul Aebersold, Isotope Branch, Atomic Energy Commission, Oak Ridge, Tennessee.

[2] The Use of Isotopes as Tracers, by A. H. W. Aten, Jr., and F. A. Heyn, Philips Technical Review, Vol. 8, No. 10, October, 1946, page 296.

that it throws light on the nature of the coating process itself—that it is an absorption phenomenon and that it approaches a saturation value.

A similar application has been in measuring the distribution of ink on paper. By placing an electrometer or Geiger counter on the printing press, an accurate measure can be made of the distribution of the ink which has previously been mixed with a radioactive isotope.

This same scheme is used in measuring the thickness of the enamel coating on refrigeration. In this case a beta-ray isotope is mixed with the enamel. As the refrigerators pass through the spray booth on the production line, a detector measures the degree of radioactivity as the refrigerators pass along and this through suitable amplifiers and relays operates the valve which opens and shuts the valve controlling the paint supply.

Tracer methods can be classified into groups, each group being concerned with similar types of problems. Thus, certain problems involve the location of certain things. Another group is concerned with quantitative problems. A third group involves exchange processes, those for example in the building of the materials in the body.

Perhaps one of the oldest examples of "tracing" is in the recovery of samples of radium that have been lost in hospitals. Naturally these samples are extremely small in size and if they were any other material they would be almost impossible to recover. Because radium is naturally radioactive, however, these samples are easy to find. All that is necessary is to go over the refuse piles where the samples might be, with a Geiger counter or electroscope.

A more modern application of this method of location is in the operation of oil pipe lines. In the periodical cleaning of the walls of the pipe, a screw-shaped scraper is placed in the line and pushed along by the pressure of the oil. If the scraper gets jammed somewhere, it has to be located quickly, in order to open the line at that point and remove the accumulated deposit. With the help of a radioactive indicator, this localization is very simple. A scraper is used that contains a little radioactive material emitting gamma radiation, which easily penetrate the walls of the pipe and can be detected with a modified form of electron counter. By merely patrolling the pipe line, with such a counter. The radioactivity will betray the position where the scraper has stopped.

Another, somewhat similar application in the petroleum industry, is in determining the setting depth of cement that is pumped in behind the casing of an oil well. As the casing is lowered through various strata, it is necessary to seal the joints by pumping cement down the tube. This cement emerges at the bottom and distributes itself around the casing on the outside, as shown in Fig. 1. It is desirable to know just how far up this cement distributes itself and also how thick the deposit is.

Previously this was accomplished in a rather unsatisfactory way by the use of thermometers, utilizing the effect of the heat produced in the setting cement.

Now, however, a much simpler and more effective way is available. All that is necessary is to mix a natural radioactive mineral, Carnotite, with the cement. Then, when a counting instrument is lowered into the drill hole, it will indicate strong radiation at the level of the cement, in fact, the intensity of radiation is also a measure of the thickness of the deposit. The chart at the right of Fig. 1 shows the record of intensity of the radioactivity.

To show the wide range of the radioactive tracer method, another interesting case is the detection of bootleg gasoline in certain areas of this country. Along the Texas border a certain quality of tetraethyl lead gasoline is distributed by the reputable oil companies. However, a bootleg product made its appearance with the result that those purchasing the product could not be certain that they were getting the genuine product or not. By mixing a radioactive isotope with the genuine gasoline, it is a simple matter for the inspectors, armed with radioactive detectors to determine which is the genuine product and which is not.

Next we consider an application where the question of mercury poisoning was involved. In factories where workers come in contact with mercury, it is highly necessary to know what concentrations exist, since the inhalation of air with a concentration of more than one ten thousandth of a gram of mercury per cubic meter of air is injurious to health. It has always been difficult to detect the presence of such small amounts of mercury by chemical analysis. In a particular instance, tubular luminescent lamps in a manufacturing plant were filled with mercury vapor at low pressure. In the process, a glass side-tube containing a small drop of mercury had to be blown into

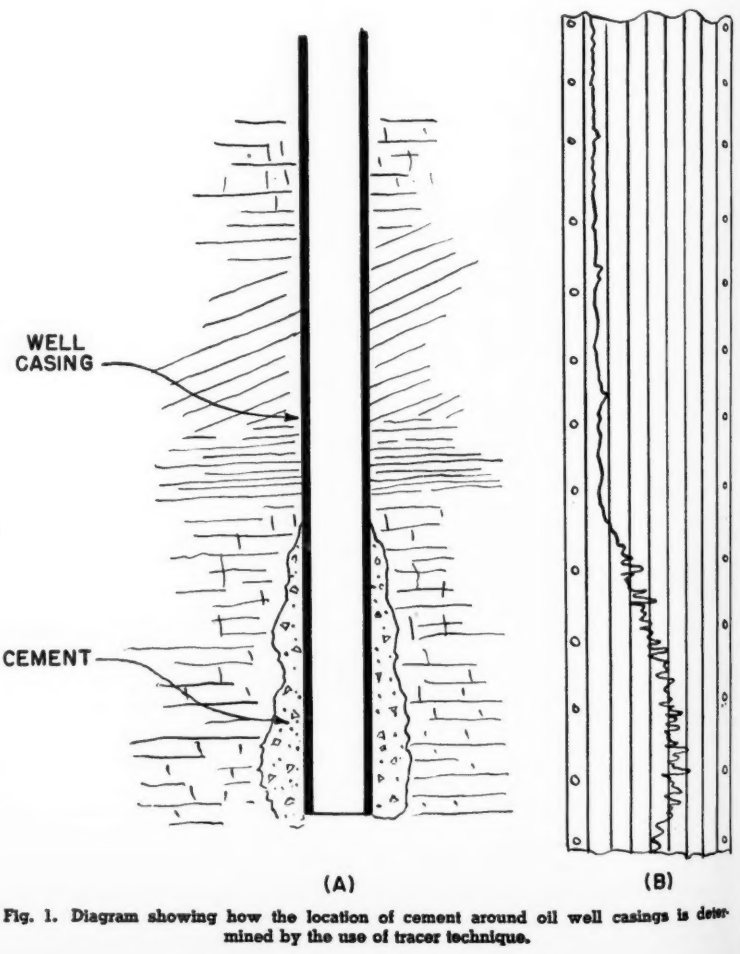


Fig. 1. Diagram showing how the location of cement around oil well casings is determined by the use of tracer technique.

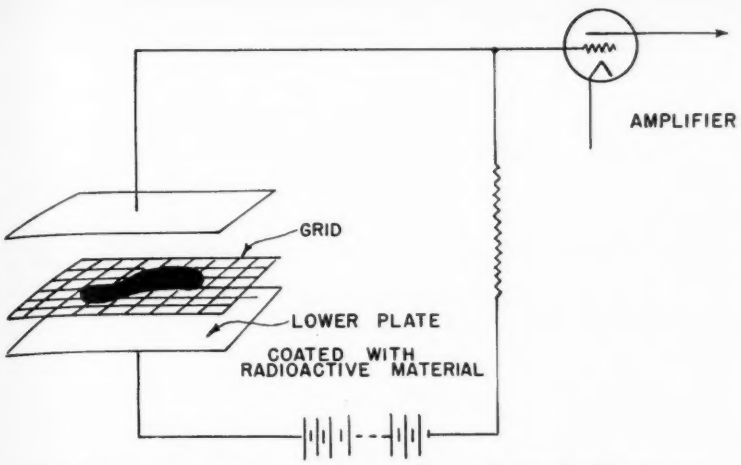


Fig. 2. Scheme using radioactive material in the measurement of odd shaped objects

the lamp, and inevitably the glass blower inhaled a very small quantity of mercury vapor into his lungs. In order to determine how much was inhaled, a number of tests were carried out with a volume of two liters of air that had been in contact with the drops of mercury under exactly the same conditions as in the manufacturing process, this being drawn off by suction and passed over a metal plate kept at the temperature of liquid air. Practically all of the mercury condensed on the plate.

The mercury used for the experiments contained a known, small percentage of a radioactive mercury isotope. The radioactivity of the plate, which was quite simple to measure after the experiment, gave an indication of the amount of mercury contained in the air which had passed over the plate. Concentration of as low as 1/5,000,000 of a gram per cubic meter could be detected in this way. Actually, the average concentration found were about 1/100,000 gram per cu meter from which it was concluded that the manufacturing process was safe— the glassblowers ran no danger of poisoning.

Measuring Odd Shapes

An entirely different use of radioactive isotopes is shown in a device illustrated in Fig. 2. Here are shown two flat plates connected to the input of a high-vacuum tube amplifier. The lower plate is coated with a compound containing a radioactive isotope. As a consequence the air between the plates is ionized, and this produces a current between the plates which is amplified and recorded or indicated.

Between the two plates is a grid. When an irregularly shaped object, say the sole of a shoe, is placed on the grid, it intercepts the rays coming from the lower plate and thus decreases the ionization, in proportion to the actual area of the object on the grid. By properly calibrating the meter in the output of the amplifier circuit, the area of the object may thus be quickly and accurately measured.

Figure 3 shows a scheme for measuring the thickness of the walls of a pipe. A milligram of radium is sealed in the end of an ionization chamber. By passing this device along the outside of a pipe or other metal surface, a certain amount of radiation from the radium will be reflected back into the ionization chamber. The amount of reflected radiation is a function of the pipe wall thickness, and so the pipe wall thickness is easily determined. By this means, internal corrosion can be detected.

This same principle can be used to measure the liquid level in a closed vessel, that is, by the use of reflected radiation, but a more effective liquid level indicator can be built by using a float, in the interior of the vessel, on which is deposited a radioactive material. The position of the float, then, can always be readily determined.

Detection of Gas Leakage

The tracer method is ideally suited to the detection of gas leakage. By mixing an isotope with a non-odorous gas, the presence of minute leaks in gas systems can easily be detected by measuring the radioactivity in the vicinity.

Another example as to how this principle can be applied is in the case of a large chemical plant. It has been claimed that toxic fumes from this plant is responsible for the destruction of crops, several miles away from the plant. The legal aspect of the situation depends upon proving that the gases from the plant actually exist at the point where the damage is said to occur. Chemical measurements are not of much avail since there are other chemical plants in the same region.

The solution, of course, is very simple, by the use of radioactive isotopes. By mixing the radioactive isotopes with the chemicals involved at the plant, it is a simple matter to measure the distribution of the resulting gases over a wide area by ionization detectors. In other words, the gases from this particular plant can always be identified in this manner.

Friction Studies

Aten and Heyn[3] mention an interesting example of the use of isotopes in the study of friction. Friction between two metal surfaces is due partly to adhesion, the result being that when the surfaces slide over each other extremely small particles of metal are torn out of one and taken up in the other. This exhcange of metal may take place to such an extent that two surfaces become, as it were, welded together—the familiar seizing. The quantity of material thus transferred from one metal to another is a measure of the contribution of the effect to the total force of friction. In general it is a question of very small amounts which chem-

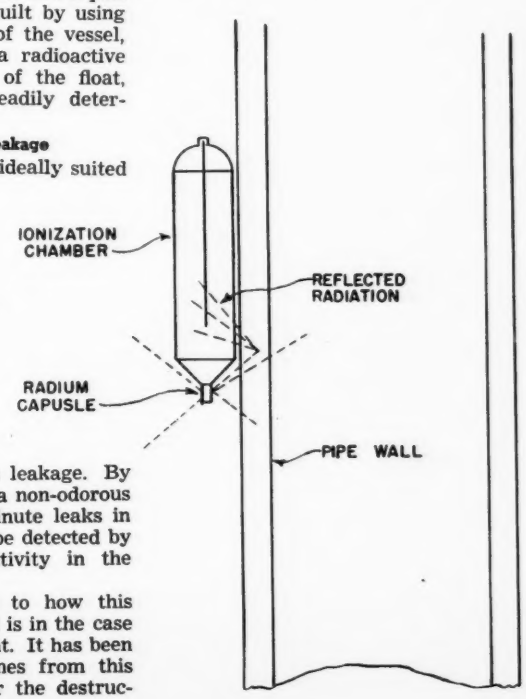


Fig. 3. Device for measuring wall thickness

[3] Ibid.

ically can hardly be detected at all. An investigation has now been carried on with the help of a radioactive tracer. One metal was "activated", that is, it consisted of a small part of atoms of a radioactive isotope of the metal. After this surface had been made to slide over the second, non-activated metal surface, the latter also showed a certain amount of radioactivity. Amounts of 1/10,000,000,000 of a gram of transferred metal were detected in this way. Furthermore, by means of a radiogram, the distribution of the transferred material on the surface could be studied.

A similar technique has been used in studying the effect of lubricating oil in bearings. By using an isotope in the bearing metal, the amount of wear can be detected by measuring the radioactivity of the lubricating oil.

Many other similar examples could be cited but these will suffice to indicate the general nature of the tracer method and its versatility.

As pointed out at the beginning of this article, much use of it has been made in the biological and medical field. In blood transfusions, for example, it is necessary to know how many of the transfused red blood cells remain in the recipient for 24 hours. For effectiveness some 70 per cent of these cells should be present after that time. Before, it was never possible to know but since tracer technique has become available, it is simple. All that is necessary is to introduce a radioactive isotope into the blood stream of the donor. Then, after the transfusion has taken place, it is possible to measure the radioactivity of the blood of the recipient and determine with great accuracy the percentage of transfused blood cells in the recipient at any time.

In the chemical field, the tracer method has proved of immense value, greatly simplifying routine analysis. One example will suffice to show how it can be used. Suppose it is necessary to determine the bromide content of a mixture of a bromide and a chloride. A complete separation of the two compounds is very difficult and takes up a great deal of time. If, however, a little radioactive bromine (in the from of the compound in question) is added to the mixture, only a partial separation of the bromine is sufficient. Due to the homogeneous mixing it is known that the ratio between the bromine separated and the total amount of bromine is equal to the ratio between the radioactivity separated out and the original radioactivity. Since the latter is easily determined, it is possible to calculate the desired total content of bromine directly from the amount of bromine separated out.

From the examples given here, it will be obvious that radioactive isotopes have great value in industry, in medicine and in biology and that their production, either as by-products in the generation of power from nuclear fission or from the production of atomic bomb material, or directly, is inevitable. Nuclear reactors of the type used at Hanford for the production of plutonium produce enormous quantities of radioactive isotopes. Ample use will be found for them in the years to come.

Clinton National Laboratory Established at Oak Ridge

University of Chicago to take over operation from Monsanto Chemical Co.; industrial groups and southern universities participate in research work on atomic energy

CLINTON LABORATORIES at Oak Ridge, Tenn., first government-built nuclear research center and principal production plant for radioisotopes, will be renamed Clinton National Laboratory to become the third in the Atomic Energy Commission's national laboratories. Fourteen southern universities in the Oak Ridge Institute for Nuclear Studies and a score of industries and industrial representatives will participate in the research, development and training programs at Clinton National Laboratory.

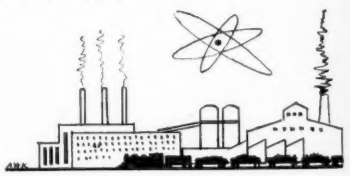
Operation of the Clinton National Laboratory will be taken over by The University of Chicago. Negotiations for a four year contract now underway with the University are expected to permit the University to complete by December 31 the transfer from Monsanto Chemical Co., which has managed the Clinton research facility since July 1945. During the period of Monsanto's operation of Clinton, the program of production of radioisotopes was developed and a broad peacetime program of research inaugurated.

The laboratory represents only a small part of the total operations carried out at Oak Ridge. The 59,000-acre reservation is also the center of a large number of AEC administrative operations and of the huge plants for the separation of uranium, operated by the Carbide and Carbon Chemicals Corp.

Operated since July 1945 by the Monsanto Chemical Co., the Clinton Laboratories have been maintained as a strong center for research and development work in the atomic energy program. Two of the major programs initiated during this period are the large scale production of radioisotopes and research on components for a power pile. Clinton also is an important center for general reactor research. Monsanto will continue to operate the extensive and expanding AEC facilities near Dayton, Ohio.

In a letter to Dr. Charles A. Thomas, Executive Vice President of the Monsanto Chemical Co., Chairman David E. Lilienthal of the Atomic Energy Commission, said the company "has performed an outstanding service to the people of the United States in managing the research facilities at Oak Ridge during and after the period of conversion from wartime to peacetime operations."

The letter stated that the "technical and managerial skills" of the company were evident in the development at Clinton of successful production processes for radioistopes, and that the Commission hoped the company's participation in this work would be "of value to Monsanto in the future atomic energy industry of the United States."



A major portion of the present staff at Clinton was employed by The University of Chicago during the war and remained as part of the Monsanto organization. The entire staff will be taken over with the exception of a small number of Monsanto executive and technical personnel who will return to the company. The new Director of the Laboratory has not yet been appointed.

Arrangements for the operation of Clinton National Laboratory were worked out with the staff and industrial participants at Clinton, representatives of the Oak Ridge Institute, The University of Chicago and the U. S. Atomic Energy Commission.

The new plan of operation for the Clinton National Laboratory brings together the Oak Ridge Institute of Nuclear Studies, interested industries, and The University of Chicago, original contract-operator of the Clinton

facilities. Plans for the original reactor (pile) and other facilities at Clinton were made cooperatively by the E. I. du Pont de Nemours Co. and the Metallurgical Laboratory at The University of Chicago. Construction was carried out by du Pont and plant operation was maintained by The University of Chicago as a part of the Metallurgical Project until July 1945.

The participation of the Oak Ridge Institute for Nuclear Studies in the Clinton National Laboratory program brings to 52 the total number of nongovernmental research institutions in the AEC national Laboratory program. Argonne National Laboratory at Chicago, successor to the war-time Metallurgical Laboratory at The University of Chicago and first of the national laboratories to be established, has 29 participating institutions throughout the Midwest. It is operated by The University of Chicago. Brookhaven National Laboratory at Patchogue, L. I., is operated by Associated Universities, Inc., which is composed of nine eastern universities.

Establishment of national laboratories was recommended by the Manhattan District's Advisory Committee on Research Policy, headed by Dr. R. F. Bacher, then of Cornell University and now a member of the U. S. Atomic Energy Commission. A major objective of the national laboratory plan was to utilize to the fullest possible extent the research personnel and facilities of academic and industrial institutions throughout the United States and to make possible a program of training in the nuclear sciences. The concept of national laboratories has been vigorously supported by the Atomic Energy Commission. Through the national laboratory program the AEC plans:

1. To make all national laboratories strong centers in the field of atomic research.

2. To develop Argonne National Laboratory and Clinton National Laboratory as parallel but separate and independent research and development institutions.

3. To emphasize reactor research and development at the Argonne and Clinton laboratories.

During the war The University of Chicago operated both the Clinton Laboratories and the Metallurgical Laboratory where the first successful nuclear chain reactor was developed and first operated on December 2, 1942, beneath the University's West Stands of Stagg Field. The Metallurgical Laboratory conducted fundamental research on problems bearing on the design and operation of the Clinton experimental reactor, and together with Clinton, on the production piles at Hanford, Washington, and on the development of plutonium recovery processes and equipment. Consequently, The University of Chicago has been associated with the research, design and development work on nuclear reactors and allied equipment from the earliest days of the atomic energy project.

The program to be carried out by the Clinton National Laboratory includes the following major projects:

1. Continued production of radioisotopes.

2. General research, including both applied research in connection with other AEC activities and fundamental nuclear research.

3. Design and construction of a new high-flux reactor several times more powerful than the existing Oak Ridge pile for further studies and expanded research requiring neutron intensities not now available.

4. Continuation of engineering studies for the development of components of reactors for the production of useful power, in cooperation with representative engineering and industrial firms.

5. Operation by the Oak Ridge Institute of a school for academic and industrial personnel, and of a program of on-the-job training by qualified graduate students with provision for credit toward advanced degrees.

The Oak Ridge Institute of Nuclear Studies was formed last year to promote activities in nuclear sciences in southern universities and to carry out a program of joint research and training utilizing the government facilities at Oak Ridge.

The present program of participation of interested industries in the basic engineering research on a power pile at Clinton National Laboratory will be continued and expanded to bring into the national atomic energy project the needed technical experience and skill of private industrial and engineering organization.

Representative groups affording working members to the Power Pile Division at Clinton are:

Allis Chalmers Manufacturing Co., Milwaukee, Wis.

Babcock & Wilcox Co., New York, N. Y.

Bureau of Ships, U. S. Navy Dept., Washington, D. C.

Combustion Engineering Co., Inc., New York, N. Y.

Fredric Flader, Inc., Tonawanda, N. Y.

General Electric Co., Schenectady, N. Y.

National Advisory Committee for Aeronautics, Washington, D. C.

National Carbon Co., Inc., Cleveland, Ohio.

Northrup Aircraft, Inc., Hawthorne, Calif.

ATOMICS

Tennessee Valley Authority, Knoxville, Tenn.

Purdue University, Lafayette, Ind.

Wright Aeronautical Corp., Woodbridge, N. J.

Westinghouse Electric Corp., Pittsburgh, Pa.

Individuals and industrial companies who are performing consultant service with the Power Pile Division are:

Allis Chalmers Manufacturing Co., Milwaukee, Wis.

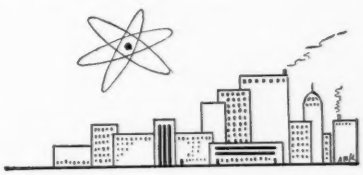
Air Reduction Sales Co., Stamford, Conn.

Babcock & Wilcox Co., New York, N. Y.

Dr. F. H. Colvin, Point Pleasant, N. J.

Combustion Engineering Co., Inc., New York, N. Y.

Dr. Farrington Daniels, University of Wisconsin, Madison.



DeLaval Steam Turbine Co., Trenton, N. J.

Foster Wheeler Corp., New York, N. Y.

Fredric Flader, Inc., Tonawanda, N. Y.

General Electric Co., Schenectady, N. Y.

National Carbon Co., Inc., Cleveland, Ohio.

Purdue University, Lafayette, Ind.

Donald W. Randolph, Cleveland, Ohio (Apex Mfg. Co.)

Westinghouse Electric Corp., Pitts burgh, Pa.

J. E. Willard, University of Wisconsin, Madison.

Wright Aeronautical Corp., Woodbridge, N. J.

J. I. Yellot, Research Director, Locomotive Development Committee, Baltimore, Md.

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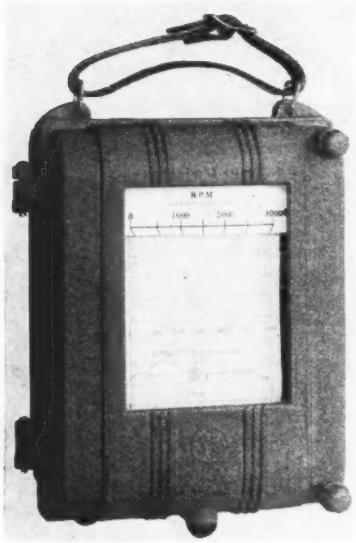
THE DIAMOND, which has many more industrial than ornamental uses, has been found to be an efficient detector of radioactivity. Exposure to gamma radiation, disturbs the electrons in the diamond's atomic structure, and creates a measurable electrical pulse. Diamonds have shown at least 1000 times the sensitivity, size for size, of any other type of counter.



Portable Inkless Recorders

Need for small, portable recorders . . . Inkless recording . . . Recorder using semi-continuous marking . . . Voltmeters and ammeters in a-c measurement . . . D-c recorders of high sensitivity . . . Measurement of non-electrical quantities . . . Applications of inkless recorders . . . Auxiliary devices

By D. M. LONGENECKER *Instrument Engineering Division, General Electric Co., Lynn, Massachusetts*

THE IMPORTANCE OF the recording instrument for attaining practical economies in plant operation is evident from the increasing number and diversity of measurements recorded in the modern power or industrial plant. In many applications, the recorders are large, and permanently - installed — sensitivity and high precision being more important than size. There is also, however, a continuing demand for small portable recorders for use in temporary installations and survey work, such as periodic checking of electrical distribution systems or the temporary surveillance of machines and processes. Since the recorder described in this article was intended primarily for this second class of application, portability was kept in mind as a primary design objective. Other objectives included adaptability to use under extreme temperature conditions, low initial cost, and minimum maintenance expense.

Inkless Recording

Design effort was also directed toward an improved marking system, since the reliability of conventional systems depends largely on proper maintenance of the inking mechanism. Further disadvantages of liquid ink in portable use include high maintenance cost, evaporation or freezing, and danger of spilling. Considerable effort has been expended in the search for a continuous-record marking system which does not use a liquid. Although such systems have been developed for specialized applications, they generally have certain disadvantages, e. g. the high cost of specially treated paper, the necessity of storing charts under controlled conditions of temperature and humidity, and the lack of permanence of the record.

Semicontinuous marking systems, however, have been found to be practical and to offer a means of eliminating liquid ink from the design. In such a system the measuring mechanism is not required to move a pen across the paper, but instead, being relieved of the frictional drag of the pen on the chart, it is free to respond rapidly to the quantity measured during a large part of the time. A pointer or marking member is used in conjunction with an inked ribbon or other medium, the pointer being clamped periodically against the chart or ribbon in such a way as to make a mark on the chart. Besides eliminating liquid ink, this system permits the design to incorporate higher sensitivity with smaller measuring mechanisms. In the conventional recorder it is necessary that the measuring mechanism deliver a high torque output to minimize errors resulting from the frictional drag of the pen on the chart. When the measuring mechanism is relieved of all frictional restraint other than bearing friction, the recorder may be designed to operate accurately at a torque of about 1/500 of that required for ink recorders, with obvious savings in size, weight, and cost. Because of the lower torque requirements, the power consumption of the measuring mechanism may be

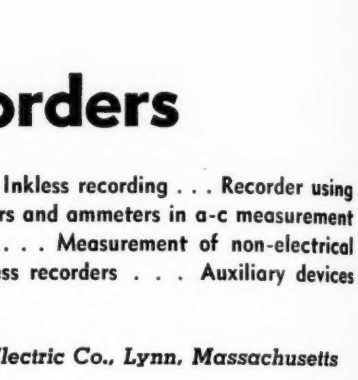


Fig. 2. Diagrammatic sketch showing a semi-continuous marking system

Ordinarily, the operating man in industrial plant or power plant is less interested in design than he is in maintenance and upkeep. To a large extent, however, proper maintenance depends upon a certain background knowledge of design; certainly knowledge of basic principles. For this reason this article on portable inkless recorders will be of interest to the operating man. It tells him a great deal about various kinds of recording instruments that he uses in his routine testing and maintenance work. It tells him what electrical and what non-electrical quantities are measured by various types of mechanisms, what accuracy these various types attain. Inkless recording, as indicated, has many advantages and permits the use of small, sensitive instruments

much lower than in ink-type recorders.

An inkless recorder designed for portable use is illustrated schematically in Fig. 2, in which a striker bar, pointer, chart, inked ribbon, and platen are the components of the marking system, and are positioned in the order mentioned[1]. An a-c synchronous motor rotates a cam at a speed of 30 rpm, producing a reciprocating motion of a vibrator arm, which is provided with a return spring. The vibrator arm is attached to a shaft to which are fastened two vertical members which support the striker bar. Thus the striker bar is made to depress the pointer against the chart once every two seconds, producing a dot on the chart each time the pointer is depressed. When the chart speed does not exceed three inches per hour and the measured quantity does not fluctuate widely, the dots merge into a solid record.

Cost and weight are kept to a minimum with only slight sacrifice of timing accuracy by the use of a simplified chart reroll mechanism and friction-type timing drum. The arrangement of the chart-carriage mechanism is such that it lends itself readily to use with a variety of measuring mechanisms. Since the required torque output is about the same as that used in indicating instruments, generally the only changes necessary to adapt the indicating mechanism to the recorder are the modification of jewelled bearings to withstand the forces incident to the action of the striker mechanism, and the addition of a strong hardened pointer. The former is accomplished by the use of pivot alloys containing tantalum and tungsten; the latter with stainless steel tubing having carefully controlled hardness and non-magnetic properties.

The practical measurements performed with this recording system are summarized in the accompanying table which shows the types of measuring mechanisms used in each application and the accuracy attained. Experimentation has also indicated the practicability of a single phase a-c recording wattmeter using an electrodynamic measuring mechanism. The mechanism is, in each case, mounted within the chart mechanism of the recorder, and its moving system is fitted with a pointer that travels in a plane between the striker bar and paper chart, as shown in Fig. 2. The response time of all the measuring devices is less than two seconds, so the true value of the quantity is recorded by the second and subsequent dots following a fluctuation. The same chart-carriage and enclosing case are used for all of the recorders, as only the measuring mechanisms differ. The illustration at the head of this article shows the typical external appearance of such an instrument, which has an approximate size of 5½ by 7½ by 10 in. and a weight of 12 lb. Chart speeds of 1, 2, and 3 in. per hr and one inch per day are provided, using a 4-in. wide chart.

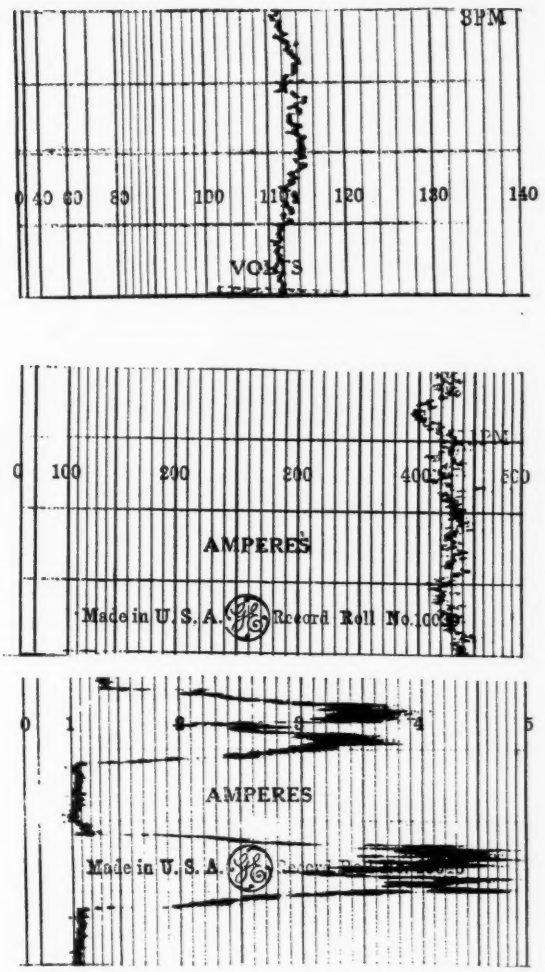


Fig. 3. Typical inkless chart records. The upper two were taken at a 3-inch per hour chart speed; the lower one at one inch per day

Voltmeters and Ammeters in A-C Measurements

Portable inkless voltmeters of the type illustrated in Fig. 2 have been applied by many utilities and industrial plants for voltage survey work and general study of distribution systems. A typical voltage chart-record is shown in Fig. 3 and is comparable with those obtained with ink recorders. A fixed coil-moving iron vane measuring mechanism of conventional design is used in this voltmeter, operating at a 90-degree torque of 1.3 gram-millimeters. The sensi-

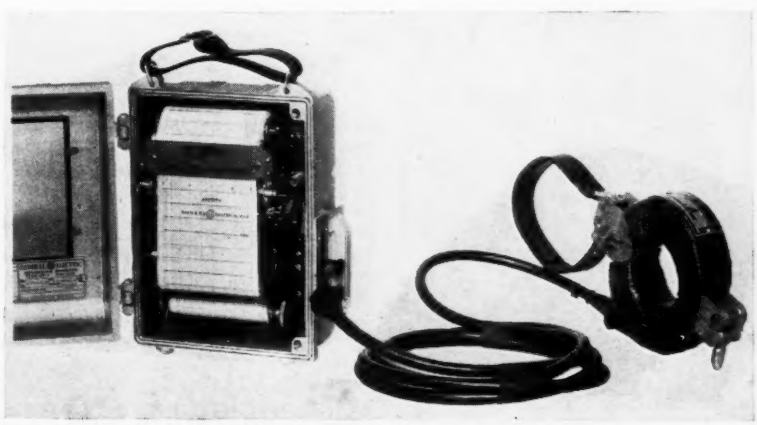


Fig. 4. A-C current-measuring set

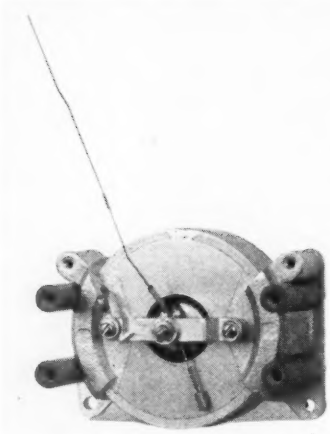


Fig. 5. D-C measuring mechanism of the permanent magnet-moving-coil type

tivity attainable with the semicontinuous marking system is apparent from the low burden — 1.0 volt-ampere at 115 v 60 cy while the ambient temperature error of only 0.015 per cent degree Centigrade permits the use of the voltmeter over a wide range of temperatures.

The same measuring mechanism is adaptable to the measurement of alternating current by providing it with a suitable field coil and, because of its low volt-ampere burden, is ideal for use in conjunction with splitcore current transformers. The arrangement shown in Fig. 4, popularly known as an a-c current-measuring set, has proved extremely valuable in industrial load surveys, since it is not necessary to break the line to install the current transformer. The chart record shown in Fig. 3b was produced by an a-c current measuring set and is typical of the semicontinuous marking system where the measured quantity fluctuates considerably. Where the quantity fluctuates even more widely and rapidly, records become somewhat more difficult to interpret, particularly where knowledge is needed of the exact shape of the measured quantity vs. time curve. In most applications, however, the information desired is the average load, or occasionally the minimum and maximum values of the quantity measured, and for such purposes the inkless system is ideal. It must also be remembered that where the quantity fluctuates very rapidly, charts taken with an ink recorder become painted with ink, thus abscuring all the useful data.

An unusual modification of the inkless recorder useful in voltage and load surveys is provided by gearing the chart for the very slow chart speed of one inch per day. Extremely condensed records such as the one shown in Fig. 3c provide much useful information to the maintenance engineer without the necessity of his scanning great lengths of chart, and often give a better overall picture of an internal resistance as low as 16 ohms.

Measurement of Non-Electrical Quantities

The sensitivity attainable with the semicontinuous-marking recorders has led recently to their use in a number of specialized measurements. As an example, a recording light meter was provided by fitting the recorder with a measuring mechanism such as the one shown in Fig. 5, designed for a full scale rating of approximately 240 microamperes and using an external light-sensitive cell (Fig. 6a) as the primary detector. Fig. 6b shows a typical record obtained with this instrument.

Further investigation with the inkless recording principle has proved the practicability of a recording temperature meter using the permanent magnet-moving coil mechanism described above, designed for a rating

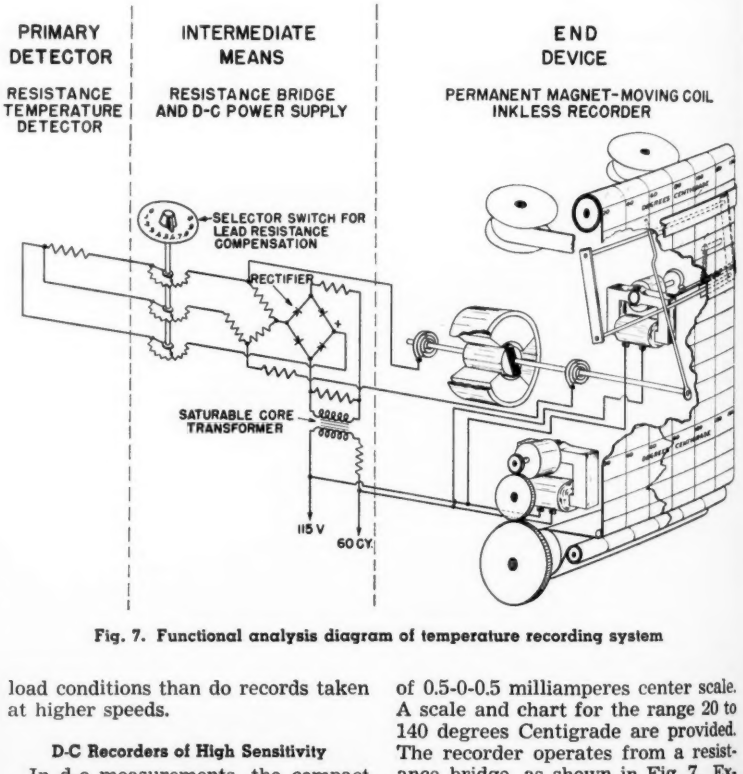


Fig. 7. Functional analysis diagram of temperature recording system

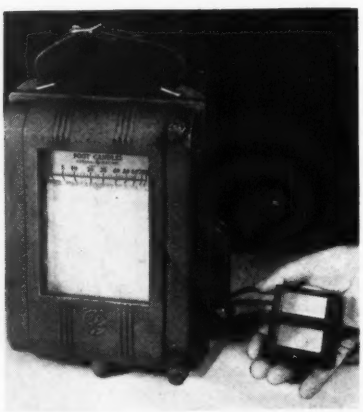


Fig. 6. Light-sensitive cell and record chart used with the recording light meter

load conditions than do records taken at higher speeds.

D-C Recorders of High Sensitivity

In d-c measurements, the compact permanent-magnet, moving-coil mechanism[4] shown in Fig. 5 is used in the inkless recorder. Since this measuring mechanism is relatively efficient, only a small amount of power need be drawn from the source, and it is possible to perform measurements requiring a recorder with a fairly high degree of sensitivity. For example, voltmeters having a sensitivity of 200 ohms per volt, with adequate temperature compensation and microammeters with full-scale ratings as low as 125 microamperes are easily attainable. A recorder of this type having a 1-milliampere scale may have of 0.5-0-0.5 milliamperes center scale. A scale and chart for the range 20 to 140 degrees Centigrade are provided. The recorder operates from a resistance bridge, as shown in Fig. 7. Excitation for the bridge is provided by means of a saturable core transformer, two resistors and a rectifier, providing a d-c voltage which is essentially constant over the range of normal variations in frequency and voltage of the a-c line. A selector switch with three tapped resistors permits compensation for variations in lead resistance of the resistance-temperature detector. The auxiliary units used with the inkless recorder to measure temperature are shown in Fig. 8. Housed in the small portable case are the bridge, transformer, rectifier and associated elements. De-

Measurements Performed with Small Portable Inkless Recorders

(A) Electrical Quantities

Measured Quantity	Type Measuring Mechanism	Accuracy in Percent of Full Scale
A-C Voltage	Fixed coil-moving iron vane	1½% within range 110-130 volts or 220-260 volts 3% over other portions of scale
A-C Current:		
(1) Directly	Fixed coil-moving iron vane	2%
(2) With splitcore transformer	Fixed coil-moving iron vane	3% to 4%
D-C Voltage	Permanent magnet-moving coil	2%
D-C Current	Permanent magnet-moving coil	2%

(B) Non-Electrical Quantities

Measured Quantity	Primary Detector	Intermediate Means	Type Measuring Mechanism	Accuracy
Illumination	Selenium cell	———	Permanent magnet-moving coil	———
Temperature	Copper resistance-temperature-detector	Bridge & d-c power supply	Permanent magnet-moving coil	3 degrees
Speed	Three-phase generator	Three-phase motor	Magnetic drag	1% of full scale

tectors for use in low-temperature ovens may be of the strip type shown at the upper right, while the bulb type shown below it is suitable for use in tanks, oil baths and similar applications. The system is ideal for recording the temperatures of electrical machines having standard 10-ohm temperature detectors imbedded in their windings.

Inkless recording has also been applied successfully in the measurement of speed using a tachometer generator of the type shown in Fig. 9, the electrical output being three-phase a-c whose frequency is proportional to speed. The generator is connected mechanically to the machine whose speed is to be measured, and electrically to the recorder. The measuring mechanism, consisting of a three-phase self-starting synchronous motor which in turn operates a magnetic drag assembly, is mounted within the recorder. The drag-disk shaft is provided with a suitable restoring-torque spring and the pointer is operated through a set of reduction gears, pointer deflection being proportional to speed.[3] In a typical application of this recording tachometer, a manufacturer of aircraft engines measured the speed of the engines during initial test runs in the factory, to determine whether the engine had been brought up to speed slowly or abused with excessive speeds.

The unique features achieved in the portable recorder by use of an inkless recording system include portability, freedom from the disadvantages of liquid ink, economy of manufacture and reliability, together with design features permitting the use of small and sensitive measuring mechanisms. Auxiliary devices and measuring mechanisms have been provided for the measurement of four electrical and three non-electrical quantities. In use over a period of eight years in the measurement of voltage and current, inkless recording has demonstrated its advantages, encouraging the recent extension of the design to include mesaurements of illumination, temperature and speed.

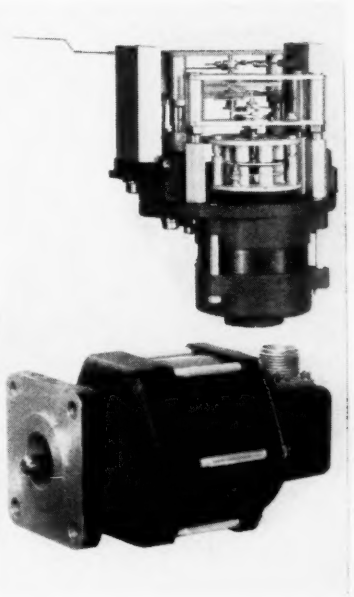


Fig. 9. Measuring mechanism and generator for the recording tachometer

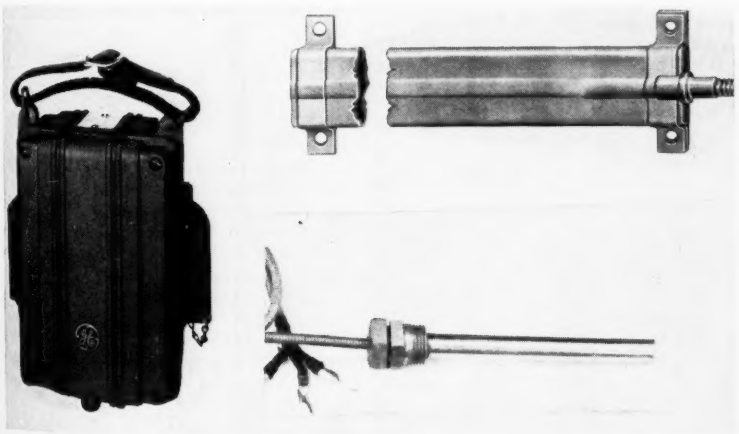


Fig. 8. Auxiliary unit and temperature detectors used with the recorder for temperature measurements

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[3] "Recent Advances in Aircraft Tachometer Design," R. G. Ballard and C. P. Hall, *AIEE Transactions*, Volume 63, pages 646-648 (September, 1944).

[4] "A New Measuring Mechanism for Direct Current," H. T. Faus and A. J. Corson, *AIEE Transactions*, Volume 59, pages 683-686 (December, 1940).

Corrosion in Boiler Feedwater Treating Systems—II

By LEO F. COLLINS, *Chemical Engineer, The Detroit Edison Co.*

IT WAS SHOWN in Part I, October issue, that, based upon weight loss measurements, common steel and (gray) cast iron corrode at substantially the same rate. In view of the relative costs of steel and cast-iron pipe, and the fact that for the same service, cast-iron pipe has roughly twice the wall thickness of standard-weight steel, it might be concluded that cast iron is to be preferred where pressure conditions permit of a choice. Unfortunately, no such generalization may be drawn. It will be shown presently, that under certain conditions, gray iron is susceptible to a form of attack commonly referred to as graphitic corrosion.*

Surfaces subjected to this form of attack rarely exhibit any of the evidences commonly associated with corrosion. The attacked surfaces appear to the eye as being comprised of normal metal, whereas, in reality, they are comprised of a black material of chalky texture that has little mechanical strength.

Both laboratory tests and field observations have revealed that gray iron, when in contact with the water in certain segments of zeolite—acid—degasification systems, experiences graphitic attack.

Laboratory Findings

The pictures in Fig. 1 are photomacrographs of a cross-section of the cast-iron test bars referred to in Table II of Part I. From these photomacrographs, it is clear that uniform attack (the dark areas) has occurred on the surfaces of the samples exposed to soft, oxygen-laden water but not to a perceptible extent on those exposed either to hard water or to deaerated soft water.

*Some German writers call this form of corrosion "Spongeosis" and "Iron Cancer."

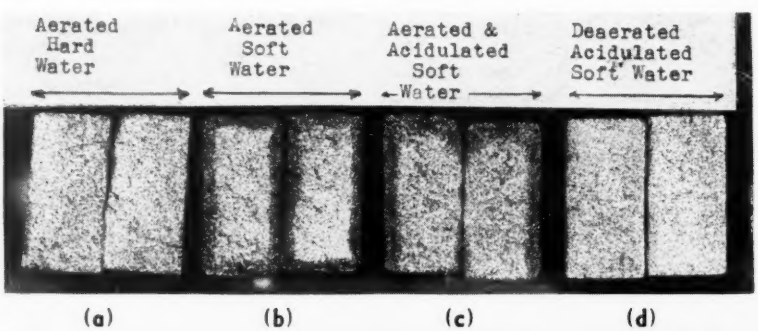

Fig. 1. Photomacrographs of cross-sections of gray iron test bars immersed for 3 years

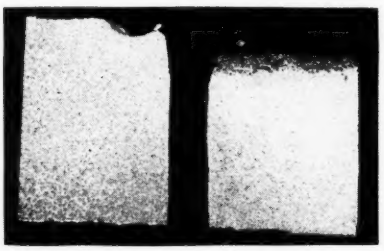

Fig. 2. Macrostructure of specimens cut from opposite sides of a gate from a division valve in service 8 years

To determine the effect of graphitization on their mechanical strength, all specimens were fractured in a testing machine. From the data so obtained moduli of rupture were calculated, using (a) the over-all dimensions of the specimens and (b) the dimensions of only the ungraphitized portion of the specimens. These values are catalogued in Table I.

To check on these results, blank flanges that had been in service for about 125 months, at comparable locations in another system, were removed and samples were cut from them. These samples were of the same dimensions as those cited in Table I. From each flange two samples were obtained: one from the dry side and the other so that one flat side was the original wetted surface of the flange. The results of rupture tests for these samples are given in Table II.

These data (in Table II) intimate that, even in hard water, graphitic corrosion may have occurred, but to an insignificant amount. If this were true, then it would seem to follow that cast iron exposed for a longer period of time should yield significant results. To check this postulate, a sample was obtained from a 30-in. water main after 64 years of service. However, no evidences of graphitic attack could be found. This main handled the same water as was supplied to the zeolite systems from which the graphitized specimens were obtained.

Field Observations

The photomacrographs in Fig. 2 are on opposite sides of the gate from an 8-in. valve in service for 8 years in a by-pass line. One side of this gate, the pitted surface, had been in contact with hard water, while the opposite side had been in contact with the same water after zeolite softening. A similar valve removed from a comparable location in another system demonstrated the same phenomenon.

Figure 3 shows a check-valve bracket that had been in zeolite-softened, aerated, weakly-acid water for 5 years. While the photomacrographs of Fig. 4 disclose that a poor grade of malleable iron was used, more importance is attached to the large black areas, believed to be the end products resulting from graphitic attack. It is generally held that malleable iron is not susceptible to graphitic corrosion, but these findings seem to challenge such a contention.

Apparently the exact mechanism of attack of cast-iron resulting in sur-

Applies especially to systems involving zeolites, acids and degasification . . . Analysis of graphitic corrosion of cast iron in such systems . . . Laboratory tests of cast-iron test bars . . . Field observations of gate valve and check valve parts . . . What causes graphitic corrosion? . . . It is essentially the result of oxidization . . . Conclusions are that in zeolite-acid water treating systems, quiescent soft waters laden with oxygen are most conducive to graphitic corrosion of gray iron . . . Part I, October issue discussed the pattern of corrosion; subsequent articles will cover performance of materials in systems scheduled, of metals in handling chemicals, comparative tests

Fig. 3. Check valve bracket, of malleable iron, after 5 years' service

face graphitization has never been definitely defined.† It is postulated that graphitic corrosion is the resultant of electrochemical reactions wherein graphite and cementite constitute the cathodes and ferrite the anodes of tiny galvanic cells (3). Baur and Wetzel (4) concluded that galvanic action and stray current electrolysis accelerate the rate of attack.

The photomicrographs of Fig. 5, show three stages in the process: (a) attack of the ferrite grains, (b) growth of the "graphite" area, and (c) advanced attack wherein the normal metal structure has been replaced with reaction products. The latter, Stumper (3) has shown, consists of small amounts of carbon and other metalloids and large amounts of ferrous and ferric oxides. Thus, it is indicated that graphitic corrosion is essentially the result of oxidization.

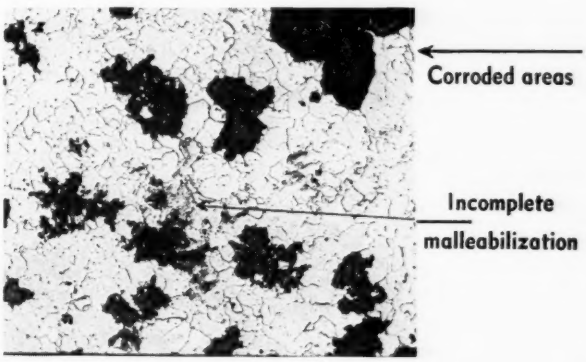

Fig. 4. Microstructure of malleable iron from corroded bracket of Fig. 3

If oxidization is the chemistry involved, and if the rate of the reaction is governed electro-chemically, then it would seem that for graphitic attack to occur (a) the contacting solution must be an electrolyte that is oxidizing in nature and (b) such an electrolyte must be in intimate contact with the iron.

In Table III are summarized the data which the aforementioned theory indicates influenced attack of the test bars shown in Fig. 2. From this summary, it appears that when hardness-imparting salts were present (and presumably therefore, produce

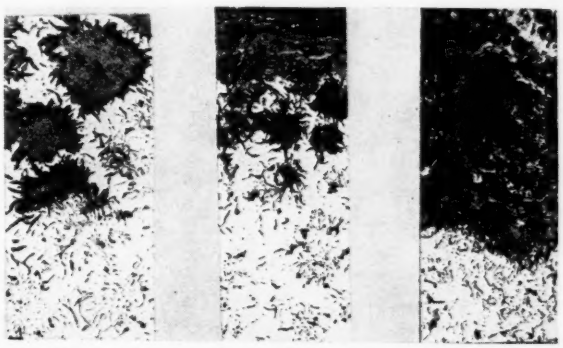

Fig. 5. Photomicrographs disclosing three stages in the process of graphitization

†A bibliography on the Graphitic Corrosion of Cast Iron appears at the end of this article. The numbers in parentheses refer to it.

Table I. Moduli of rupture for test bars

TYPE OF WATER INVOLVED	Moduli of Rupture (1) (a)	(b)
A Hard Water (Municipal Supply)	42,600	42,600
B "A" after Zeolite Softening	23,800	50,900
C "B" plus Acid Addition and Aeration	24,500	45,000
D Same as "C" but Deaerated	49,800	49,800
O Non-exposed Specimen	54,900	54,900

(1) Modulus of rupture, R (in psi) $= \frac{3\ wl}{2\ bh^2}$

Where w = loads in pounds to cause failure
l = length of span — inches
b = width of test bar — inches
h = thickness of test bar — inches

(a) Using over-all dimensions of test bars.
(b) Using dimensions of ungraphitized portion of test bars.

Table II. Moduli of rupture for samples cut from blank flanges (1)

TYPE OF WATER INVOLVED	Moduli of Rupture lb per sq in. (2)	(3)
A Hard Water (Municipal Supply)	36,660	40,370
B "A" after Zeolite Softening	27,990	31,170
C "B" plus Acid Addition and Aeration	14,450	44,520
D Same as "C" but Deaerated	35,950	33,310

(1) Flange had been in service about 125 months.
(2) One flat side of these specimens was the wetted surface of the flange.
(3) The specimens cut from outside (dry) side of flanges.

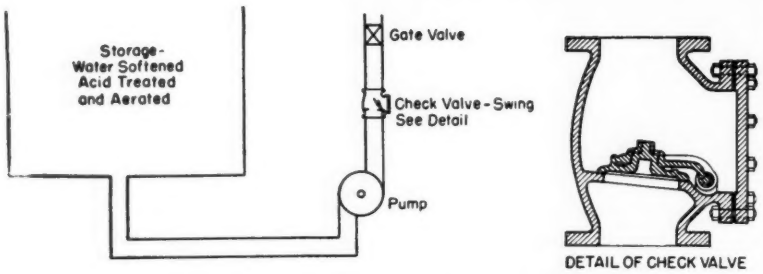

Fig. 6. Check valve location and cross-section of valve

a protective film on the metal) no attack took place even when large amounts of oxygen were present; that when such protective films were absent and large amounts of oxygen were present, graphitic attack occurred at a rapid rate; that when little or no oxygen was present, corrosion did not occur even in the absence of protective films.

Except for one point, the above seems to offer a satisfactory explanation for attack of the test bars. The exception has to do with specimen (c) Fig. 1, which is noted to be attacked on two edges and unattacked on the opposite edges.

While searching for an explanation for this phenomenon, it was observed that the top of a cast-iron disc from a check valve (handling the same type of water as surrounded specimen (c) Fig. 1), was graphitized on the top side and virtually unattacked on the bottom.

The valve in question was installed as shown in Fig. 6. From the latter it is clear that when the pump operated, water at a high velocity traversed the bottom (unattacked) side of the disc; when the pump stopped (the valve closed), water was at rest on the top of the disc.

The implication that flow velocities influence graphitic attack, an observation also made by Bauer and Wetzel, inspired a critical examination of the positions in which the test bars (Fig. 2) were installed. This revealed that specimen (b) Fig. 1 had been submerged in a large tank, whereas specimen (c) had been located in a pipe line in the manner shown in Fig. 7. It is believed that the unattacked edges were those which faced the flow stream.

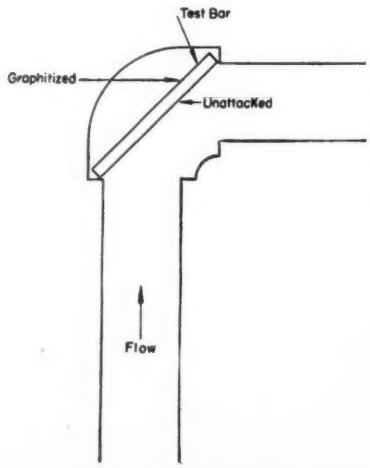

Fig. 7. Sketch showing installed position of sample (c) of Fig. 1

Conclusions

From these observations, it appears that in zeolite-acid water treating systems, quiescent soft waters laden with oxygen are most conducive to graphitic corrosion of gray iron.

Those acquainted with the chemistry of the corrosion of ferrous materials will readily recognize that iron or steel specimens exposed to such conditions can experience only limited losses in weight. As such, "mild" corrosion will be indicated. Even so, it is clear that cast iron exposed to just such an environment may be subject to sufficient graphitic attack to reduce its mechanical strength a significant amount. This is an insidious type of corrosion, since its extent is not likely to be disclosed by visual inspections.

(To be continued)

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Table III. Factors that determined rate of graphitic attack and chemical characteristics of solution contributing to graphitization

TYPES OF WATER INVOLVED	Conductivity (1)	O_2 ppm	pH Value	Temp	R (2)
		"Graphitizing" Waters			
Zeolite Softened Water	260	11	7.6	50	30
Zeolite Softened & Acidulated Water	300	6	6.2	60	35
		"Non-Graphitizing" Waters			
Hard Aerated Waters	250	11	7.4	50	None
Soft Deaerated Water	290	>0.02	8.7	215	None

(1) Microhms at 25 C.
(2) Growth of Graphite Layer—Inches per Year × 1000.

NEW BOILER, GENERATOR, FOR LAKE LINDEN COPPER PLANT

IMPROVEMENTS at the power plant of the Calumet & Hecla Consolidated Copper Co. at Lake Linden, designed to increase the capacity from 22,000 kw to 24,000 kw are under way.

In considering this project, the company called in the Chicago firm of Vern E. Alden company, engineers, to make a survey and analysis. Their investigation, covering a period of three months, showed that a saving of approximately $300,000 per year in operating costs could be effected.

The changes involve a pulverized-fuel Riley boiler which will be erected in the Lake Linden plant. This boiler is rated at 206,500 lb of steam per hour at 850 psi and 825 F. It will

New equipment will eliminate this

have a capacity to furnish steam for present operations, the proposed new turbine, and also will have available steam for the Calumet mill if additional milling facilities in excess of present requirements are needed.

The new equipment will consist of a 7,500 kw Allis-Chalmers non-condensing turbine operating at 850 psi and exhausting at 160 psi. This turbine, operating at 3,600 rpm, will drive, through a reducing gear, a 6,000 kw, 13,800-v generator which will feed into the system. Mounted on the same shaft will be a 1,700 kw 2,300-v generator and auxiliary drives. The exhaust from this topping turbine will flow to either No. 1 or No. 2 turbine units. It is estimated that this combination will produce power at a coal consumption of slightly less than one pound per kw.

In addition to the new equipment No. 1 and No. 2 turbines will be thoroughly overhauled and brought back to near the original operating efficiency. An agreement has been made with the Alden company for the purchase and erection of this plant.

It will take about two years to complete this work.

The Spreader Stoker Today

Present development and history . . . How the underthrow and overthrow types operate . . . Considerations to be observed in furnace design and installation . . . Stationary, dumping, and traveling grates . . . Overfire air jets . . . Cinder reinjection . . . Operator cautions . . . Wide capacity range

AMONG THE different kinds of coal burning equipment available for use under power boilers, the spreader stoker is meeting with increasing acceptance, particularly in industrial plants, using poor quality coal. Its ability to burn poor quality coal is one reason for its popularity. Other reasons are: simplicity of operation, the ability to burn an unusually wide range of fuels, flexibility in handling widely fluctuating loads, high rate attainable with little clinkering tendency, and the low maintenance with high efficiency.

The war and coal strikes have made users of coal cautious when selecting coal burning equipment to be sure to get the stoker that will handle the widest range of fuel.

From the end of the war to date there have been several hundred spreader stoker installations made. Ninety per cent of these installations were in the food, chemical, and paper processing industries, where wide swings in the load demand consideration.

In operation at this time are plants varying in size from 10,000 to 250,000 lb of steam per hr. Not only in capacity is the range wide but also in pressure, varying from low pressure heating boilers to steam generators operating at 1250 psi.

Aside from the main reasons mentioned, there are several other factors about spreader stokers that are attractive to the purchaser and operator: namely, low initial cost, light foundation requirements, small amount of boiler room space required, ease of installation in present boilers.

Spreader stokers are not new. They were developed and used in Europe, Canada, and the western United States for at least 50 yrs. The basic principle of operation is sound but as long as good coal was available in most places at low cost, development lagged. In recent years, with the coal becoming poorer, interest increased in the spreader stoker until today it has reached a high state of development.

Early types were little better than hand firing and were used mostly on small installations or where the coal to be burned was of poor quality but right at hand. The early types used standard natural draft grates with the usual large air openings and with practically no regulation of coal and air supplies. Control of the spread was not uniform because of the crude design of the rotor blades. They were really nothing but mechanical shovels.

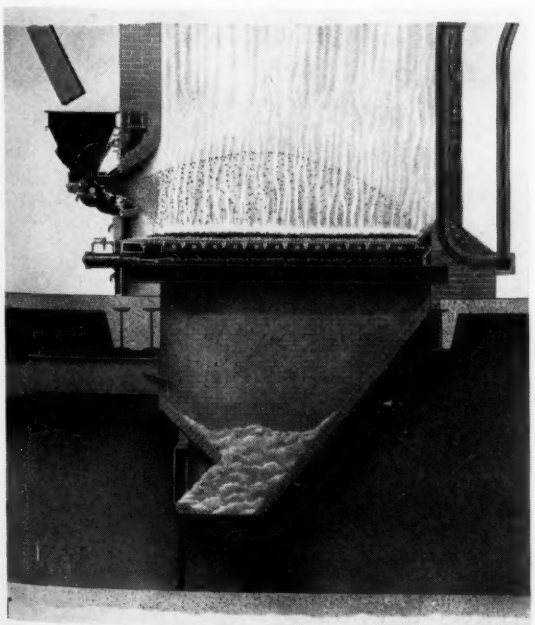
Today the spreader stoker is a finely engineered piece of fuel burning equipment. Years of experimenting enabled designers to produce the correct angle of the rotor to achieve perfect spread, feeder control that covers the full range of operation, and grates specifically designed for the problems involved with the poor grades of fuel usually used.

Essentially, a spreader stoker consists of a flat grate, fixed or traveling, together with a means for spreading the coal uniformly over the entire grate area. In the mechanical type of spreader stoker this is usually accomplished by means of a rotating wheel (Fig. 2), carrying blades which scatter the coal over the grate area. Naturally, some of the coal burns in suspension, but most of it burns on the grates in the usual manner. In the pneumatic type of spreader stoker, which will not be considered here, compressed air scatters the coal over the grate.

The Spreader Stoker

The heart of the modern spreader stoker consists of three parts, the hopper, the feeder, and the spreader rotor itself.

The hopper, the sides of which should have an angle of 35 deg. or more, is of standard construction with smooth interior surfaces to pre-



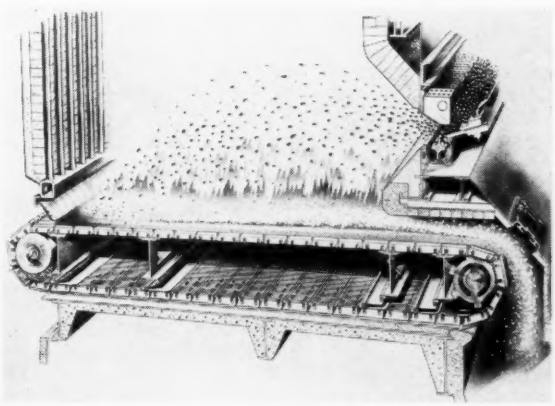


Fig. 1. Spreader stoker with power operated dumping grate. The plenum chamber and ash pit are combined (Courtesy of Detroit Stoker Co.)

Fig. 2. Spreader stoker with traveling grate. The plenum chamber is zoned. Ash discharges over front end into ash pit (Courtesy of Bros Boiler Co.)

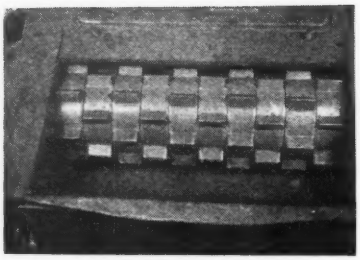


Fig. 3. Rotary feeder for underthrow spreader stoker (Courtesy of Combustion Eng. Co.)

vent the high percentage of fine particles from sticking. The coal flows by gravity to the feeder plate or chain.

Feeders are of three basic designs, the bar, chain, or rotary (Fig. 3). The bar type is by far the most commonly used (Fig. 4). In this type the coal falls onto a plate that has a reciprocating bar sliding back and forth on it. A linkage connected to the bar varies the length of the stroke and in this manner controls the rate of feed. The feeder plate can be moved in and out to change the spilling point at which the coal hits the rotor blades. Both adjustments mentioned can be performed manually at the front of the stoker. Inclusion of these controls in the automatic control system is simple (Fig. 6).

The chain type of feeder usually has a gear driven chain with blades at right angles to the chain travel thus carrying the coal to the rotor in a positive motion. The speed of the chain may be varied from the outside, while running, to suit load conditions and the adjustment of the throw changed to suit the fuel.

The rotary type of feeder utilizes a rotor with staggered blades that push the coal onto the rotor of the spreader. The rotor of the feeder can also act in a minor capacity as a crusher. The speed of this rotor is varied to suit the load.

There are several spreader stokers being built today, the only outstanding difference being that a few are of the underthrow type but most are of the overthrow type. Breaking it down even further is the design of the blades. Some consist of one solid blade running across the rotor, others are in segments, each segment being curved or angled slightly different than its neighbor. One has the blades mounted in slots in which the blade is free to move in and out, thus compensating for any wear that may result from contact with the coal, and to allow fairly large foreign articles to pass without damaging the spreader.

An important feature of blade design is the angle the blade makes with the rotor axis (Fig. 4). The purpose is to achieve an even spread across the grate so that combustion is even and no section of the grate burns faster than the others. There is a variation here, too, between the stationary and dumping grates (Fig. 1), and the traveling grates (Fig. 2). A larger size of coal burning on a traveling grate would necessitate adjustment of the spreader to throw the heaviest lumps were they would have the longest travel time on the grate. Large sizes of coal may require reducing the speed of the rotor as much as ⅓. These adjustments would be necessary to hold down the amount of combustible in the ashpit.

The drive for the feeder and spreader is practically always combined to the same driving motor or turbine (Fig. 5). In the case of the traveling grate models at least one manufacturer has the spreader, feeder, and the grate driven by the same machine. The hydraulically driven units can be controlled from full capacity to a complete stop with the driving motor still running.

The feeder housing, feeder, and rotor, are directly exposed to the

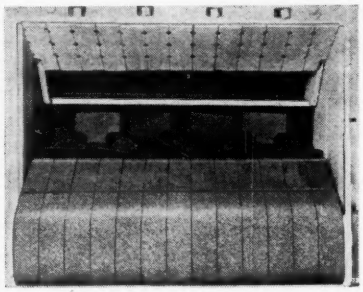


Fig. 4. Spreading rotor of overthrow type. Note various angles of blades, also the feeder plate and bar (Courtesy of Riley Stoker Corp.)

heat of the fire and some method of cooling is necessary to keep the temperature down and prevent burning of the parts. Either water at a pressure or air at several inches of water pressure will accomplish the cooling satisfactorily.

Dust around the boiler room must be kept off the moving parts and this is done by immersing the moving parts of the feeder in oil and covering the whole unit with a light weight metal casing (Fig. 6).

Grates

Three different types of grates can be used with the spreader stoker, the size of the unit usually being the determining factor, although, the grade of coal used may have a bearing on the choice.

For small units, where the rate of burning is not so large, the stationary grate can be used. This is a simple, inexpensive installation. Because the ash may be on the grate for periods up to eight hours provision must be made to allow for expansion and possible growth resulting from the ash. Most makers have grate cooling fins which extend into the windbox from each grate section.

Dumping grates, either hand or power operated, make up the greatest number of installations because they are in the medium size range. The design of the grates has a strong influence on the combustion turbulence and efficiency. The air admission ports amount to about 10 per cent of the total grate area. This results in low velocity and a crisscrossing of the air streams. Some manufacturers have tuyere type grate bars, others have flat bars. In the end it is the lack of clinkering, low air velocity, and good turbulence, that dictate the choice of grate design. Power dumping grates use either steam or air cylinders for dumping (Fig. 1).

Traveling grates, with a few exceptions, have only just been introduced to use with the spreader stoker. They are of the same basic construction as the standard traveling grate but the air admission ports and the design of the individual grate bars are different (Fig. 7). The speed is also slower than the standard grate, being from 1 ft to 4 ft per hr. The grate may travel toward either the front or back. The drive for the grate is either a small electric motor or turbine, geared (Fig. 6) to the grate gear at a ratio of about 5000 to 1 varying to 73,000 to 1. There are a few grates that utilize the stepless feature of hydraulic transmission.

Nearly all the grates, stationary, dumping, or traveling, are zoned off in the air chamber under the grate (Fig. 2). There may be only two zones on the small units and three on the larger ones. This is across the grate on traveling grates but on dumping and stationary units the zone runs with each section of the grate, so that the air may be cut off while the fire is being cleaned on that section, thus holding down the excess air in the furnace. With the traveling grate the zones are spaced to aid combustion with the proper percentages of air, because the thickness of the fuel bed varies as the grate travels.

With the quality of coal what it is today the selection is of the stoker

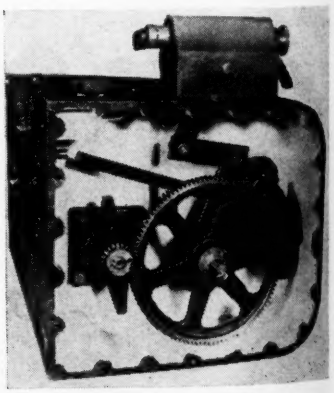


Fig. 5. Spreader stoker feeder driving mechanism with automatic control (Courtesy of Riley Stoker Corp.)

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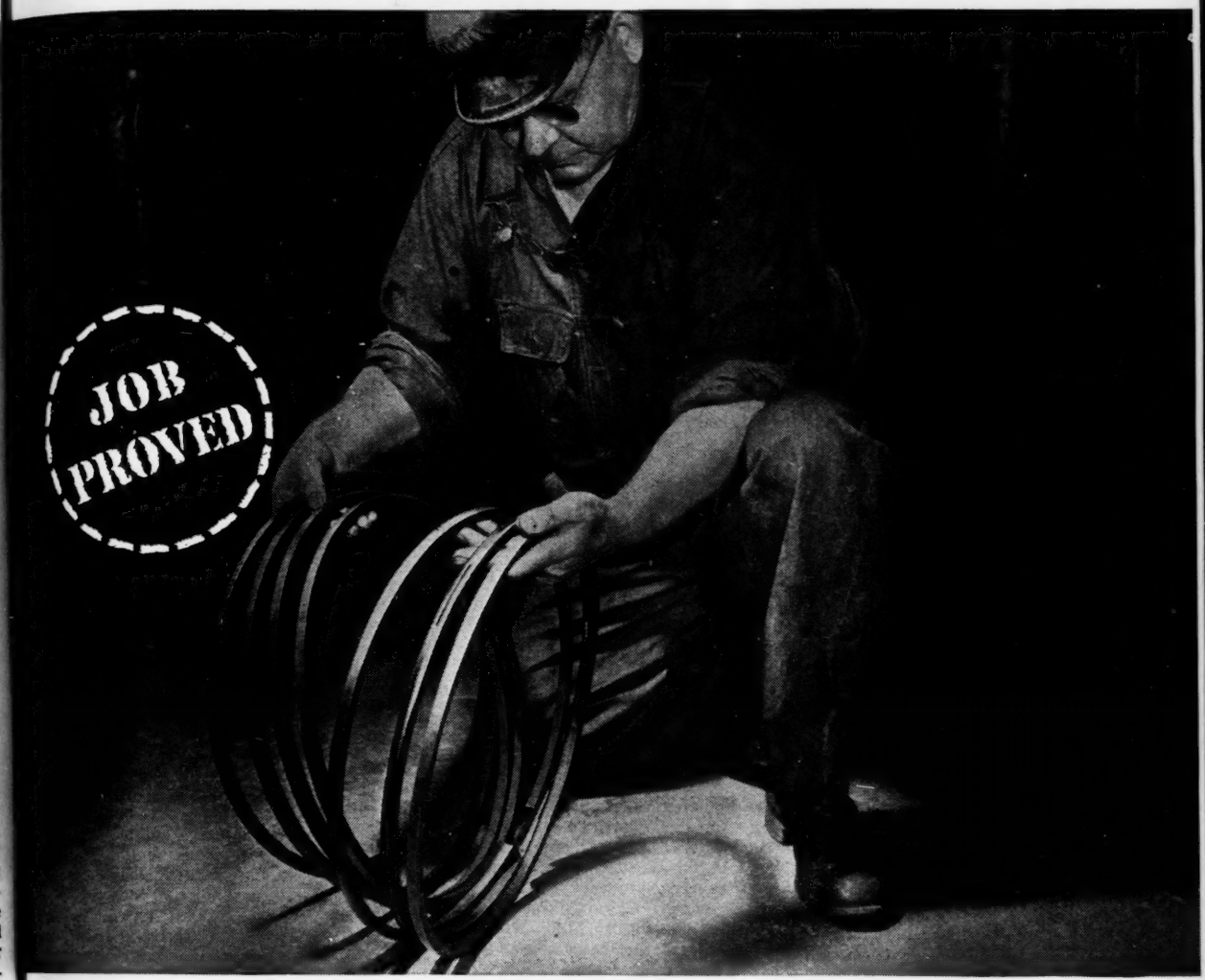

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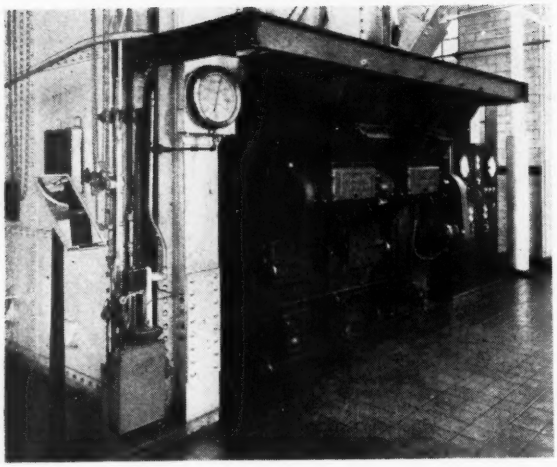

Fig. 6. Power dumping grate under spreader stoker with full automatic combustion control (Courtesy of Detroit Stoker Co.)

to fit the fuel rather than the reverse. That is why the spreader stoker has the most universal application. It can, and will, burn coal varying from semi-anthracite to lignite. A coal with a low ash—high volatile rating is considered best, particularly in relation to the fly-ash problem.

Present installations are burning a variety from low volatile, high Btu (14,000) down to lignite containing 40 per cent moisture and under 7,000 Btu per lb. Coking and non-coking coals give equally good results. When using a stationary or dumping grate it is best to burn a coal with a low ash content so as not to have to clean the fire too often.

Generally, the grade of the coal is not so important as the size. There is much discussion on sizing but the generally accepted best size is ¾ in. X 0 in. for use in most installations. In the largest furnaces it may be necessary to use a larger size to reach the back of the grate at the same rotor speed. Larger and smaller sizes may be burned but they create differences in combustion that call for changes in adjustment. The larger sizes would result in more burning on the grates with a lower fly-ash carryover but a greater loss in combustible in the ash pit and possible clinkering. The smaller sizes, such as bug dust, would have the opposite effect. With the traveling grate a higher ash content coal can be burned because the depth of the ash on the grate varies but slightly.

Fly-ash

Because as much as 50 per cent of the fuel is burned in suspension the carryover of fly-ash may be considerable, especially with a high volatile content coal. This presents several problems, but none that cannot be solved. If combustion rates per sq ft become too high, for too long periods, erosion and slagging of the tubes may result. Cinder traps are generally designed by using baffles to change direction and slow down the velocity of the gas and thus allow the carbon particles to drop out. Before reaching the stack the gas passes through a cyclone separator which catches practically all of the particles still flowing that the cinder traps did not halt. This unburned material is then reinjected into the furnace by air pressure for more complete burning. If the fly-ash gets too heavy it may result in a deposit building up on the blades of the induced draft fan, throwing it out of balance and causing vibration.

Overfire Air

Nearly all spreader stoker manufacturers favor, and insist upon, installation of overfire air jets. (Fig. 8.) These may be either air or steam, but air is favored. Important is the fact that it is the high velocity, not the volume of air, that is wanted from these jets. The best location for the jets must be determined by each installation, although, in general, a jet in each corner is usual practice. Properly located and with sufficient pressure the turbulence created by the jets can make a decided difference in the combustion. The design of the jets themselves is sufficiently interesting and important to demand a separate article.

Ash Disposal

The type of grate used will usually determine the method of ash disposal. The stationary grate, of course, must be cleaned by hand and the ashes removed externally, either by water trough or hand. The dumping grate has a regular ash pit under it (Fig. 1) and anyone of several methods may be used to carry the ash away. One point that is favorable to the disposal is that the ash is friable and easily handled. There are very seldom any clinkers.

The traveling grate empties into a pit at the front or rear of the furnace (Fig. 2). This is the easiest grate from which to handle the ash as it is friable and non-clinkering and will flow along with water pressure or vacuum without undue clogging.

One of the outstanding reasons for the popularity of the spreader stoker is its adaptability to present boilers without too much redesigning of the furnace. About all that has to be done is to remove any bridge walls, old grates or stokers, and the front of the furnace. In the case of a low set HRT boiler it might be necessary to dig down a short way in order to provide space for a combustion chamber of proper size.

The forced air supply is brought into the plenum chamber either from the rear or side, whichever is most accessible. In the case of a new boiler it is often possible to place the fan and air ducts right in the walls of the boiler.

The most desirable furnace conditions are: high rectangular shape; no ignition arches; waterwalls to increase the radiant heat transfer, lower the gas temperature, and protect the refractories. Volume should be enough to give a maximum furnace liberation of 30,000 to 35,000 Btu per cu ft.

Care must be taken that the waterwall is not so extensive as to cool the furnace too much and so retard combustion. Usually the waterwall tubes are spaced on centers of twice the tube diameter (Fig. 2).

One very important point is to determine whether the breeching to the stack and the stack itself will handle the full output of the stoker. The spreader stoker can pick up rating so fast that experience has shown that it may produce more products of combustion than can be safely handled and a pressure may develop, burning the parts.

The grate design and size must consider whether the grates are of the traveling, stationary, or dumping type. If the grate is of a traveling type the area can be smaller because the ash is being continuously cleaned, and so does not cut down the air flow. For best combustion results the rate in lb per sq ft is 40 lb. This can go as high as 55 lb per sq ft for short peak loads. A continuous overload may result in slagging and erosion of the tubes at the entrance bank due to the high velocity. At normal rating the velocity is low (35fps) enough so that this doesn't happen.

The only practical limitation on

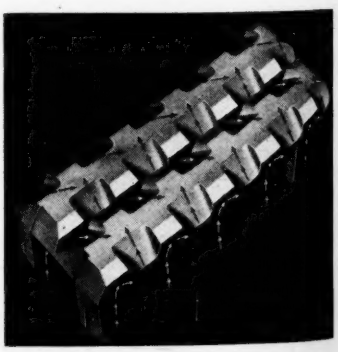

Fig. 7. Grate bar for traveling grate showing crisscross air pattern (Courtesy of Bros Boiler Co.)

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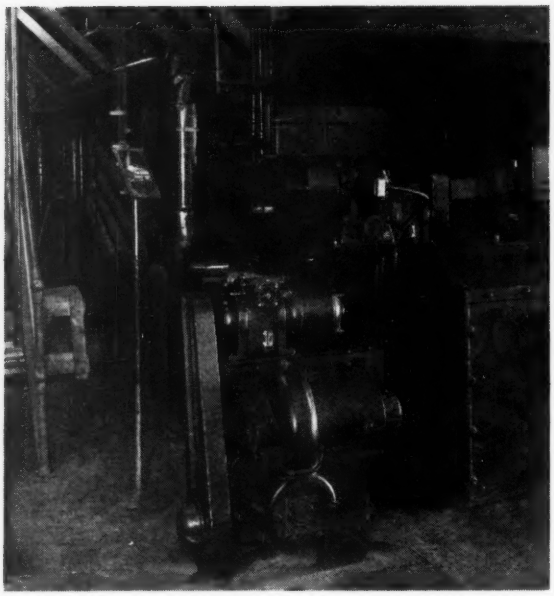

Fig. 8. Independent drives for feeder and rotor, and traveling grate. Note preheated air pipe (Courtesy of Detroit Stoker Co.)

units using the spreader stoker is the depth of the furnace. To date that depth is 14-15 ft but one manufacturer has experimented and found that coal can be thrown with the spreader up to 24 ft. They are building one at this time that will have a traveling grate with a 20 ft length in the furnace.

When planning an installation it is imperative that the ash-disposal system be considered. This will vary with the type of grate. The dump and traveling grates are the only two that require an ash pit of some kind. With the dump grate this is usually the lower part of the plenum chamber, while with the traveling grate it is in the form of a hopper at the discharge end of the grate. Water is usually used to carry the ash away from the pit, but where the unit is high enough trucks of various kinds may be used (Fig. 1).

It is feasible to include air preheating equipment (Fig. 8) to increase efficiency of combustion. It is recommended that the air temperature be held to 400 deg or less. This preheated air may be used for the cinder reinjection system, but is not recommended for the overfire air.

Soot blowing, when the boiler is equipped with overfire air and cinder reinjection, is held to a minimum. Some plants report that they only have to blow soot after a sustained period of heavy loads. The use of retractable soot blowing elements is becoming more widespread where this stoker is in use. Since it is only necessary to use the blowers at certain times, maintenance costs are kept down by using the retractable elements.

Operation

The spreader stoker requires less attention than some other types of stokers on the part of the operator. Aside from the water and steam end the operator has two main points to keep check on. One is the spread of the coal on the grate. With the stationary and dumping grates the spread should be even across and up and down the grate. This will be affected by a change in the size of the coal, which may arise from changing from one coal to another or be the result of segregation in the hopper when using wet coal. A considerable variation in the load will also have an effect.

The other point the operator has to keep in mind and check frequently, is the cinder reinjection system. If this is automatic or continuous he doesn't have to watch it so close, but, as in a small plant, it may be intermittant depending upon the operator's schedule and the load. In connection with this it is important that the operator be notified of any changes in the coal supply or of impending wide swings so he can compensate for them immediately.

The overfire air is usually continuous and as such demands just routine checking to keep operating properly.

Control of the spread is important because if it should get off the grate serious burning and slagging can result that will materially cut down the continuous operating time. If, as has happened, the cinder reinjection air pressure should become too strong it may cross the furnace completely and impinge on the opposite wall, slagging it, and if unobserved eventually eroding the tubes or refractory.

The traveling grate calls for the spread in a different way than the other two grates. Since most of these grates travel to the front of the furnace it is necessary that the largest lump be thrown to the rear so they will have the longest possible burning time on the grate before being dropped to the ash pit. The grate speed should be regulated so that all combustible matter is thoroughly consumed. This will vary with the grade of coal but will run on the average from 7 per cent to 15 per cent. Cases are on record where the unburned particles were as little as 3½ per cent of the ash.

Since the traveling grate runs continuously there is no problem there to cleaning ashes. With the stationary and dumping grates there are a few. The stationary grate is cleaned by hand with a hoe and bar. The dumping grate is dumped into the ash pit, cleaned of any clinkers, and returned to service. Both of these operations are preceded by shutting off the feeder for the section to be cleaned, allowing the fire to be burned out and then closing the forced air damper nearly all the way to prevent admission of excess air to the furnace. The ash deposit can be allowed to reach a depth of 4-6 in. before cleaning is necessary. It is advisable not to clean the grates before the 4 in. depth is reached as too-frequent cleaning may cause burning of the grates. The ash is an insulator and should be used as such.

Maintenance of the motor, fan, grate, and stoker bearings should follow recommendations of the makers unless otherwise determined. The water or air pressure on the feeder jackets should be checked at regular intervals. Failure to do this will put the feeder and spreader rotor out of action in a short time.

SUBSTITUTION of a national water policy for the present piecemeal development of water programs, to eliminate jurisdictional conflicts and confusion and to insure maximum benefit from "this element of wealth which is as much a national resource as the country's minerals," was recently discussed in a report by Dean Thorndike Saville of New York University's School of Engineering, before fellow members of the Board of Direction of the ASCE.

The Society's recommendation for a nationwide survey of the country's water resources, made last April, was endorsed and made the subject of Resolution No. 1 adopted by the National Water Conservation Conference in Kansas City, Mo., in September.

"The point is," continued Dean Saville, "that there is *no* point merely in continuing the discussion. For, while the arguments rage, confusion continues to pile upon confusion. What is needed is a broad study leading to establishment of a national policy, with clearly defined positions for all subdivisions of government in a co-operative effort between the various states and the federal government; with the public completely protected and assured of economic planning and construction of water projects by unbiased reviews by engineers who have no continuing interest in such developments."

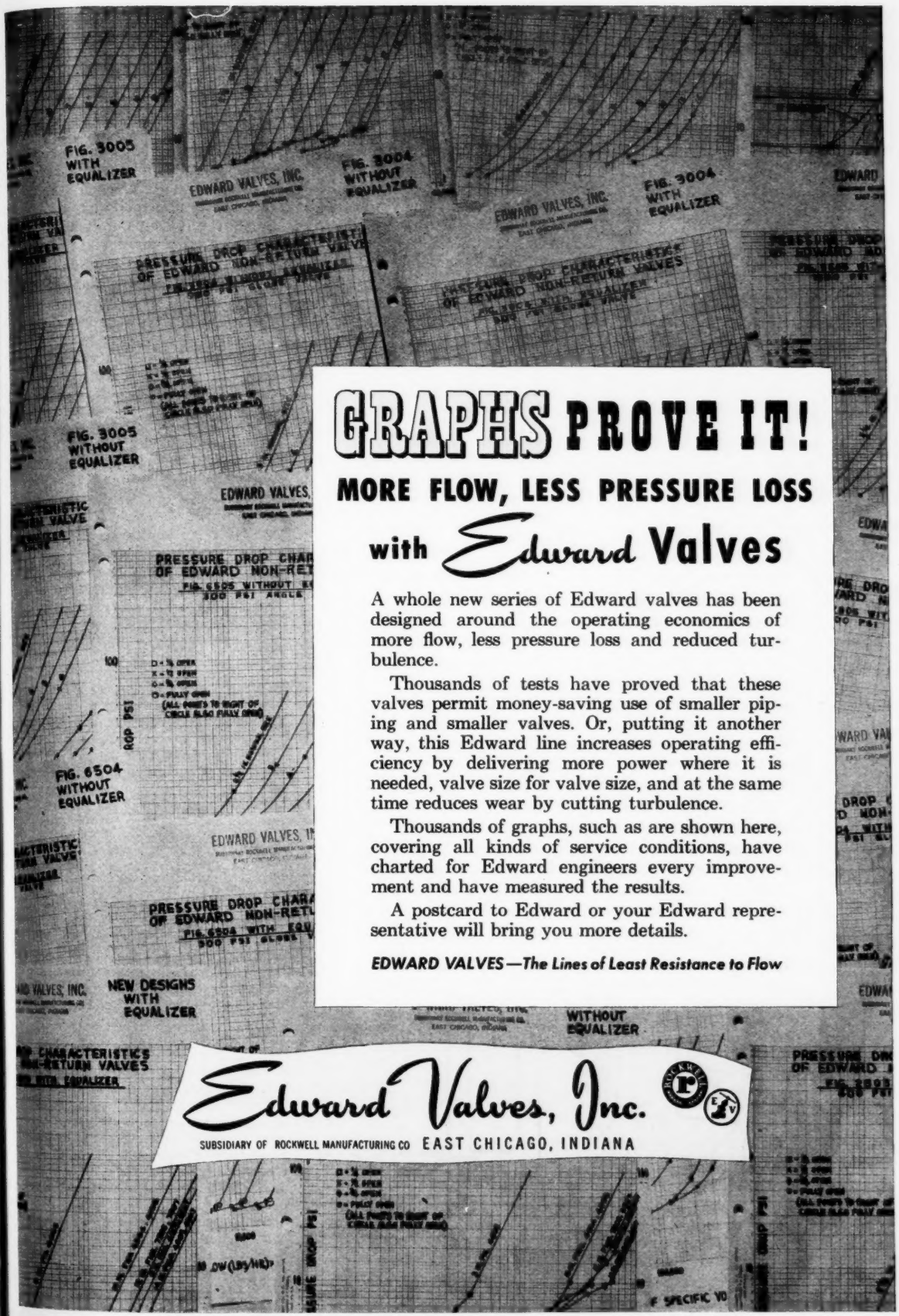
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FIG. 3004 WITH EQUALIZER
PRESSURE DROP CHARACTERISTICS OF EDWARD NON-RETURN VALVES
FIG. 3005 WITHOUT EQUALIZER
EDWARD VALVES,
PRESSURE DROP CHARACTERISTICS OF EDWARD NON-RETURN VALVES
FIG. 6504 WITHOUT EQUALIZER
EDWARD VALVES, INC.
NEW DESIGNS WITH EQUALIZER
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The Gas Turbine Power Plant—VII

Analysis of various existing gas turbine plants from point of view of their functions . . . Four major fields already entered by gas turbine are: plants supplying hot or cold air but no power; plants supplying air and generating power; plants generating power with no utilization of exhaust energy; plants to generate power and process heat . . . Characteristics of each type . . . Operation of the Houdry process gas turbines vital in establishing commercial importance of gas turbine . . . The gas turbine as a refrigeration machine . . . Development of the gas turbine as a prime mover . . . Industrial gas turbine power plants to produce both power and process heat to be discussed in next and last article of this gas turbine power plant textbook

By JOHN I. YELLOTT

Director of Research, Locomotive Development Committee, Bituminous Coal Research, Inc.

THE FIRST ARTICLE of this series (POWER PLANT ENGINEERING, January, 1947) gave a brief summary of the principal types of gas turbine power plants. Succeeding articles discussed the components of a gas turbine plant—air compressors, heat exchangers, combustors, and turbines—and showed how preliminary estimates of plant performance can be made. This article will present a classification of existing gas turbine plants with respect to the functions they perform.

Although the gas turbine is in its technological infancy, enough experience has been acquired in the operation of certain types to enable the future possibilities of this prime mover to be evaluated.

It is important that the limitations as well as the advantages of the gas turbine plant be well understood, for its future development will depend upon wise selections of the uses to which the early units are put.

Four major fields of usefulness have already been successfully entered by the gas turbine plant, each field being one where its characteristics give it a marked advantage over other prime movers. These four fields may be defined in the following terms:

I. Plants to supply hot or cold air for other prime movers, jet propulsion, or chemical processes, with little or no power to be developed.

II. Plants to supply air and to generate some power.

III. Plants to generate power for land, marine, and aircraft, with no utilization of the kinetic energy of the exhaust.

IV. Plants to generate power and process heat.

In addition to these major divisions, there are a number of experimental plants which are worthy of mention. A future application that must be borne in mind is the utilization of the heat which will be available in nuclear energy piles. Nothing definite can be said of this application at this time, although it seems unlikely that nuclear energy plants will challenge fuel-burning units in the near future.

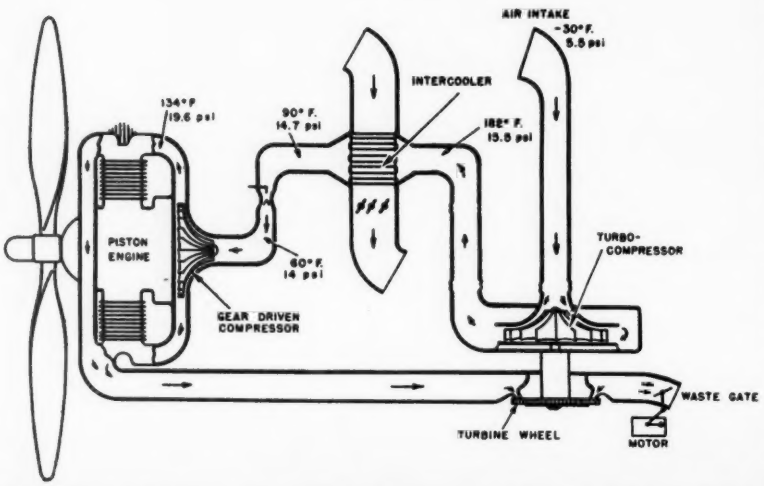

Fig. 1. The aircraft turbo-supercharger (General Electric Co. and Minneapolis-Honeywell Co.)

I. Air Supply Systems

The "gas" that drives the open-cycle turbine is atmospheric air, to which varying amounts of combustion products have been added. In the early days of the gas turbine plant, compressor capacities and efficiencies were so limited, and allowable turbine inlet temperatures so restricted, that it was impossible to obtain any net power from the shaft.

There are, however, many applications where the generation of power is not required, but where there is need for a steady supply of air in large volumes at moderate pressure for the combustion of liquid or solid fuels. Foremost among such applications is the aircraft engine supercharger, which boosts the pressure of the air being supplied to piston engines so that their performance will not fall off as the plane rises into higher and rarer air. The pioneering efforts of the late Dr. Sanford Moss at the close of World War I, and in the years which intervened before the second World War, resulted in the development of the exhaust-gas turbine-driven supercharger to the point where literally hundreds of thousands were used by the United States air forces.

In principle, the turbo-supercharger is quite simple, for it consists only of a single-stage, full-admission turbine through which the hot exhaust gases are discharged. The turbine wheel, rotating at very high speed, drives a single-stage centrifugal compressor, which delivers air at moderate pressure through an air-cooled heat exchanger to the engine. Figure 1 shows its general principle of operation, with the waste gate which allows the turbo-charger speed and output to be regulated by "dumping"

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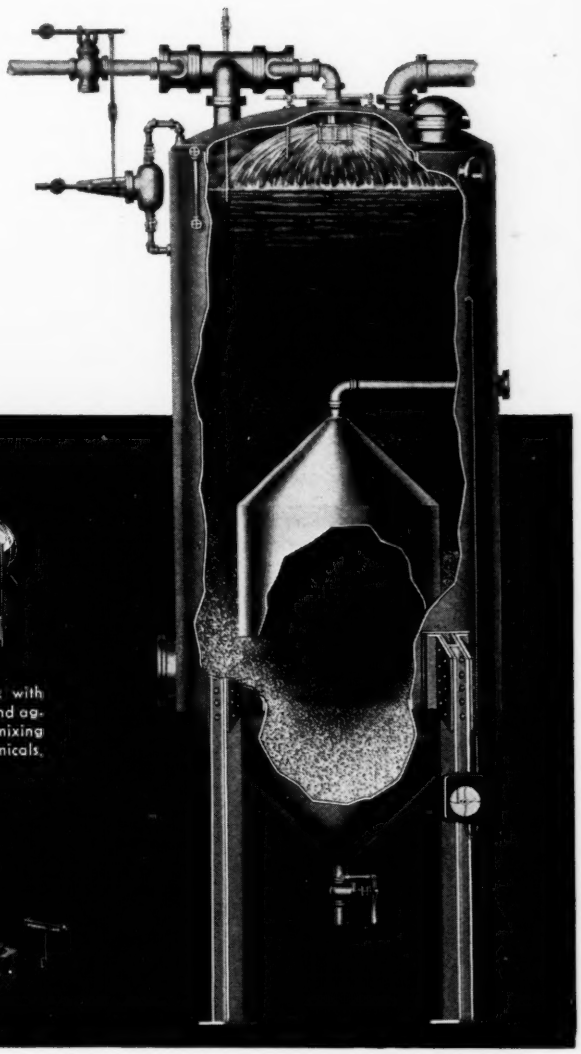

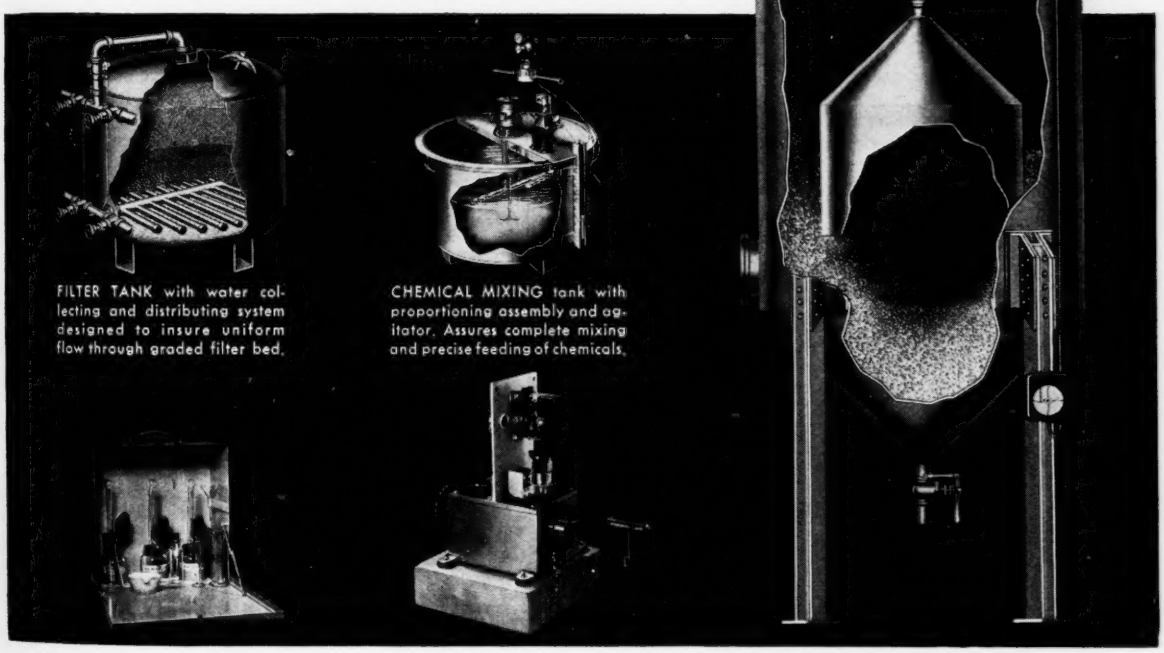

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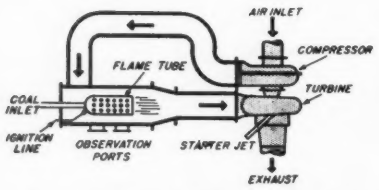

Fig. 2. "Bootstrap" combustion unit used in coal-burning gas turbine tests at Battelle Institute

the excess exhaust to the atmosphere. The story of the development of the turbo-charger was told by Dr. Moss (1, 2—references at end of article) and his paper contains a comprehensive bibliography of articles relating to the early history of the gas turbine.

Turbo-Chargers and Turbo-Jets

The vital importance of the turbo-charger in military aircraft caused the National Defense Research Council to sponsor a broad investigation of high-temperature metals, and the alloys which resulted will be widely used in the gas turbine power plants that are now being built. The similarity of the typical turbo-jet engine to the turbo-supercharger is evident, and the rapid development of jet-propelled aircraft owes much to the pioneers who perfected the turbo-charger.

Combinations of compressors, combustors, and turbines have been widely used in laboratories to supply air for experimental purposes. For obvious reasons, the term "bootstrap" is applied to arrangements such as that of Fig. 2, where a compressor is driven by a turbine to which it supplies the necessary air through a combustor. The turbine-compressor combination can be started by a small jet of compressed air, and, after the fuel is ignited, the unit can become self-sustaining if the pressure drop between the compressor and the turbine is kept small.

The turbo-charger has also become virtually standard equipment on high-performance Diesel engines. In this service, long life is essential, and materials are used that are capable of operating continuously for 100,000 hours (ten years). The Elliott-Buchi turbo-charger, one of the most widely used, is shown in Fig. 3.

The Buchi system (1, p. 45) differs from the Moss aircraft turbo-charger in establishing special timing of the Diesel engine cylinders, separating the exhaust periods so that the impulses will act independently and successively against the turbine blades. This separation is possible because the Diesel has fewer cylinders and runs at a far lower rotative speed than the aircraft engine.

Other combinations of compressors, piston engines, and turbines have been proposed, in which the turbine is used to generate some or all of the required power output. The piston engine is used primarily to drive the supercharging compressor. Very high thermal efficiencies are predicted for these systems, but they are limited to fluid fuels. Mechanical difficulties of considerable magnitude also exist when attempts are made to gear the piston engine and the exhaust-gas turbine to the same shaft.

Variations of the turbo-charger can be used to secure cold air for testing aircraft components, cabin cooling, and, eventually, for industrial processes. Figure 4 shows one possible combination, in which a large volume of air is compressed and then cooled by an air-swept heat exchanger. A part of the air is then expanded through a small but efficient turbine, where work is extracted from the air, chilling it and supplying part of the necessary compression work. The remainder of the air from the intercooler goes to the aircraft engine and is exhausted through a second turbine, which supplies the additional work needed to drive the compressor.

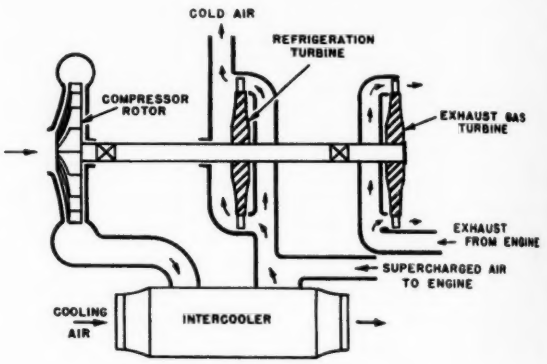

Fig. 4. The gas turbine used as an aircraft cabin cooling refrigerator

Velox Boiler Important in Gas-Turbine Development

The Velox boiler, Fig. 5, played an important part in the development of the gas turbine power plant (3, 4). A product of many years of work by the Brown Boveri Co. on the Holzwarth explosion-cycle gas turbine, the Velox boiler might be described as a supercharged steam generator. The axial-flow compressor draws in atmospheric air and raises its pressure to about 35 psia. The air then enters the combustion chamber where liquid or gaseous fuel is burned. Water walls lining the combustion chamber absorb some of the heat released by the burning of the fuel. The combustion products pass upward from the bottom of the flame zone through a large number of small passages between the water-filled tubes, which are located in this annular space. The combination of high velocity, small diameter of gas path, and super-atmospheric pressure results in a very high over-all rate of heat transfer, reducing the gas temperature to about 1500 F, and the pressure to 33 psia.

Under these conditions the gases flow downward through the superheater, which they leave at about 31 psia and 900 F. Next, the gases enter the multi-stage reaction turbine, where the pressure drops to 16.5 psia, and the temperature is lowered to 700 F. The turbine drives the compressor directly, and a small motor is geared to the same shaft. This motor is used for starting the set, but under favorable conditions of

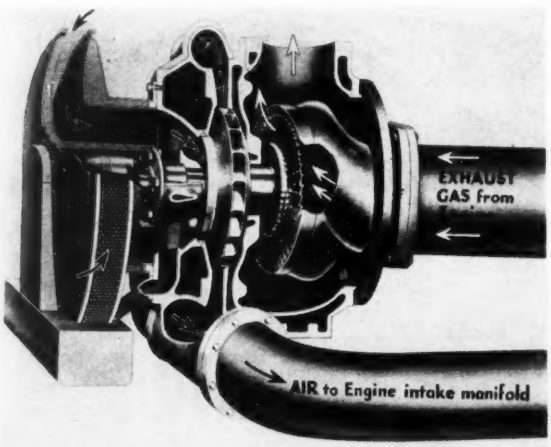

Fig. 3. The Elliott-Buchi turbo-supercharger for diesel engines (Elliott Co.)

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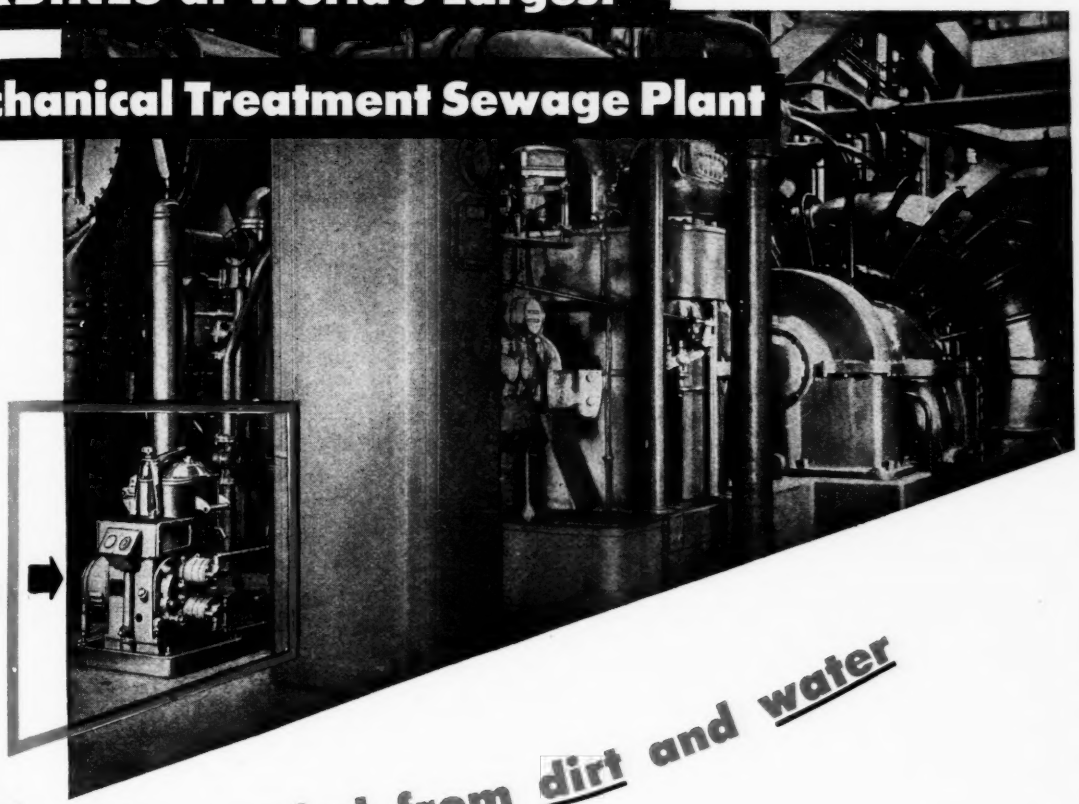

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outside air temperature, it can act as a generator to produce useful power.

The exhaust from the turbine passes through an economizer before it is discharged to the atmosphere. The feed water is pumped through the economizer to the inlet of a circulating pump, which forces large quantities of water upward through the water walls and the convection tubes in the annular gas outlet passage. The mixture of steam and water passes to the separator drum, where the water is whirled out of the steam, which then goes on to the superheater.

The Velox boiler operates at very high efficiency, and it is characterized by compactness, light weight, and rapid response to load changes. Several hundred Velox steam generators have been installed in stationary plants, and one locomotive has been built with this type of boiler.

II. Plants to Supply Air and to Generate Some Power

Many industrial processes can operate more efficiently if they can be supplied with large volumes of compressed air. The supplying of this air is usually very expensive, however, and a large steam plant is required to provide power for the compressors. That the gas turbine can fill this need effectively is demonstrated by its application to the large number of Houdry fixed-bed catalytic oil cracking units now in use throughout the world.

In this process, high-octane gasoline is made by passing vaporized heavy oil through beds of pelleted catalyst. As the oil is cracked and converted to gasoline, the excess carbon remains behind on the catalyst as coke. At intervals of about 10 minutes, this coke must be removed from the catalyst by a process of controlled combustion called regeneration. By using compressed air for regeneration, the coke removal is speeded up and made more complete, while the equipment is much smaller than it would have to be for atmospheric pressure operation.

The apparatus used in the Houdry process is shown in Fig. 6, adapted from the paper on this subject (5) by J. E. Evans and R. C. Lassiat. An axial compressor supplies air at about 60 psia to a preheater, which raises its temperature to about 750 F. The air is introduced to the cases where it burns off the coke deposits on the catalyst pellets. The products of combustion leave the case at about 850 F, 55 psia, and pass through the turbine where enough work is done to drive the compressor and to produce up to 900 kw of excess power.

Molten salt is circulated through the cases to recover much of the heat given off during regeneration; process steam is generated by passing the salt through a boiler. The combustor shown between the cracking case and the turbine is used only for starting up the unit, as is the preheater burner in the compressed air line. By using multiples of three cracking cases, one is always kept on the line while a second is being regenerated and the third is being vacuum-purged.

Importance of Houdry Process Gas Turbines

The successful operation of gas turbine power plants in the Houdry process has been of the utmost importance in establishing the commercial value of this new prime mover. The first Houdry unit, of Brown-Boveri manufacture, was installed in the United States in 1936 by the Sun Oil Co. at Marcus Hook, Pa., and it has been in virtually continuous service since that time. In a comprehensive report on Houdry process gas turbines (6), A. E. Pew, Jr., reported on the operating record of 26 units, 6 of Brown Boveri and 20 of Allis-Chalmers manufacture. The maximum time off due to turbine troubles was 3.10 per cent for one unit, in which the thrust bearings failed. Substitution of Kingsbury type thrust bearings for the ball bearings originally supplied has virtually eliminated this difficulty.

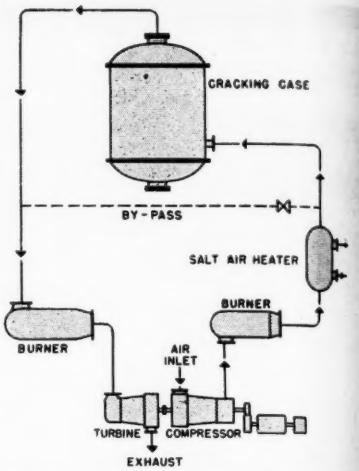

Fig. 6. The gas turbine in the Houdry oil refining process

Abrasion of the stationary blades has been observed in some installations in which leakage of powdered catalyst has taken place. It is apparent from appearance of the turbines that the solid particles were thrown out by centrifugal force to the turbine casing, where they cut away the roots of the first rows of fixed blades. A battery of small mechanical separators has been installed on one unit that had experienced this difficulty. Preliminary tests indicate that the abrasive solids are being removed to such an extent that no further cutting is taking place.

It was the excellent record of the Houdry units, which operate on solid fuel, that encouraged the Locomotive Development Committee to undertake the work on the coal-burning gas turbine which was described in Part VI, POWER PLANT ENGINEERING, September, 1947. The Allis-Chalmers plant, which is now on order for one of the L. D. C. experimental locomotives, is quite similar to the largest of the Houdry units.

The Prop-Jet Turbine

Another very important power-plus-air gas turbine plant is the propeller-driving gas turbine, which uses its exhaust for jet propulsion. Prop-jet units of many types are now under development in the United States and abroad. Best known of the American designs is the General Electric TG-100, which uses an axial-flow compressor to supply air through a number of small, individual combustors to a single stage turbine. The turbine drives the compressor directly, and supplies power through a reduction gear to a variable-pitch propeller. The exhaust from the turbine, which is wasted in straight power units, forms the jet which also helps to drive the plane.

English manufacturers are work-

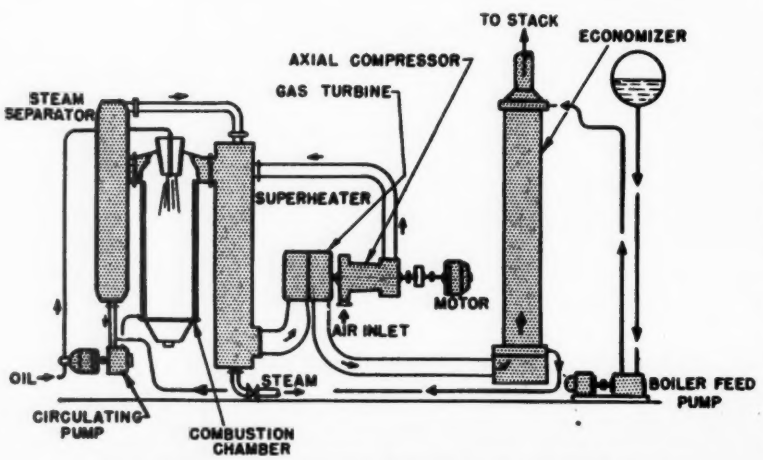

Fig. 5. Principle of operation of the Velox boiler (Brown Boveri Corp.)

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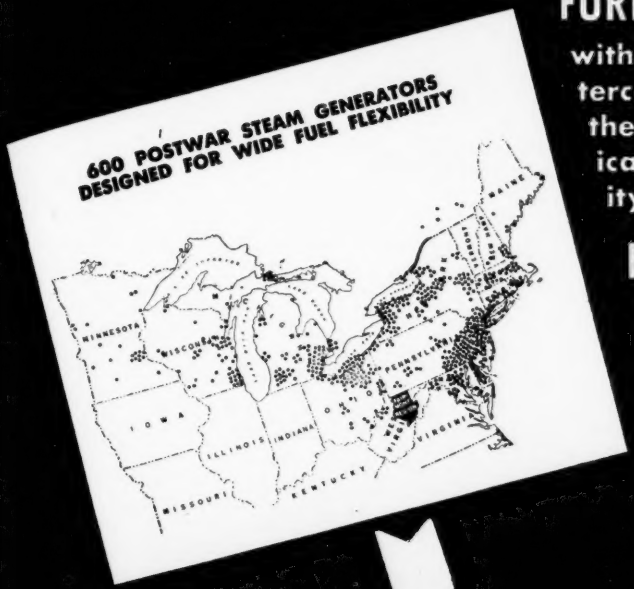

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of sufficient capacity to maintain design rating of steam units with hardest structure coals.

STOKERS . . .

with sufficient grate area to avoid excessive fuel bed temperatures.

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These modern postwar units ranging in size from 10,000 to 1,000,000 pounds of steam per hour were designed from the ground up for WIDE FUEL FLEXIBILITY.

To protect against any contingency of normal and abnormal coal supply, practically all these modern installations were designed to conform to the following basic maximum and minimum fuel specifications. *These specifications are not actual coal analyses.* Instead, they are tolerance values, which provide factors of safety to assure high capacity, troublefree, economical operation with a wide range of coals.

As a result, furnaces were designed with sufficient volume and watercooling so that (furnace) exit-gas temperatures will not exceed ash-fusion temperatures *on the oxidizing basis*. Likewise the units have ample pulverizer capacity, or stoker grate area, to insure adequate fuel flexibility.

FUEL SPECIFICATIONS
Basic Maximum and Minimum Values

Maximum Moisture	10%
Maximum Volatile	38%
Maximum Ash	12%
Maximum Sulphur	3.5%
Minimum Grindability (Hardgrove)	50
Minimum Ash-Softening Temperature	2000 F

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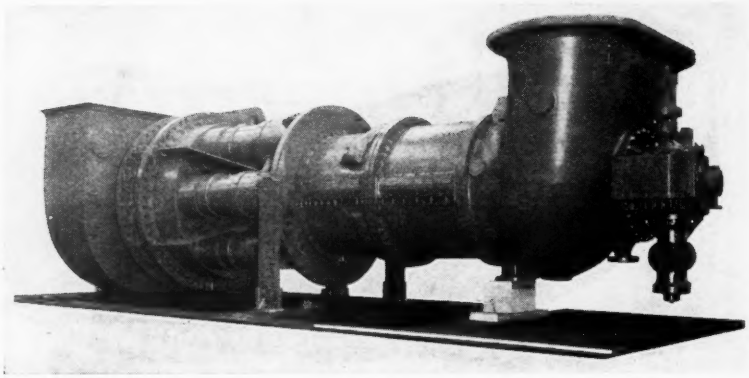

Fig. 7. Full-size model of the General Electric 4800-hp oil-fired plant for locomotive drive

ing on other forms of the prop-jet system, one of which uses a first turbine to drive the compressor, and a second turbine to drive the propeller. Another variant on the same general idea is to use the turbine to drive a "ducted fan," which is essentially an enclosed propeller which forces additional air through the engine nacelle to the jet, and thereby creates additional thrust. Students of jet propulsion theory and practice are advised to read references (1) and (7) in the Bibliography, as well as to study the literature of the aircraft industry.

Blast Furnace Application

Still another type of plant which is designed primarily for air supply is the blast-furnace blower set which has been proposed, with several units now in service, by Brown Boveri (4, 8). Blast furnaces require very large volumes of air at pressures from 20 to 35 psig. It is customary to obtain this air by using a steam turbine to drive a multi-stage centrifugal blower. By using a large axial compressor, the blast air can be extracted at any desired pressure and the remaining air, further compressed, put through a heat exchanger (regenerator) and then a combustor, and used to drive the turbine, which will power the compressor. The blast furnace gas, cleaned of its dust, can be compressed in a small auxiliary compressor and used as the fuel in the combustor. A somewhat similar solution has been proposed by Dr. Meyer (4) to the problem of supplying air to large wind tunnels.

In summary, wherever large volumes of compressed air are required at moderate pressure, a gas turbine plant can usually be designed that will supply the air and make use of the exhaust after the air has served its purpose. Single compressors can supply up to 100,000 cfm at pressures up to 75 psia, and the required power can often be obtained without the expenditure of additional fuel making use of waste heat from the process.

III. Plants Intended Primarily to Generate Power

The goal of gas turbine designers has been the development of a plant which could attain a thermal efficiency high enough to enable it to compete with other prime movers. This goal was reached during the 1930's, with the simultaneous appearance of alloys with ability to withstand 1100 F and compressors with efficiencies above 80 per cent. Since turbines of excellent efficiency had been perfected for use with steam, and combustion under pressure presented no particular problems for liquid fuels, all the components were at hand to produce for the first time a gas turbine power plant which could take its place with the steam plant and the Diesel engine.

Neuchatel First All-Power Unit

The Brown Boveri Company was the pioneer in this field, and their 4000-kw plant at Neuchatel, Switzerland, was the first gas turbine central station plant. Put into operation as a peak-load unit in 1939, this installation used the open cycle with no regeneration, intercooling or reheat. It was intended to serve as a bomb-proof, water-free emergency unit, and detailed reports of tests, conducted in July, 1939, by the late Dr. Aurel Stodola, were the first published data on gas turbine power plant performance. Operating with a maximum turbine inlet temperature (t_{T1}) of 1067 F, and a pressure (p_{T1}) of 61 psia, the unit delivered 4021 kw at the generator terminals, or 4184 kw at the coupling. For fuel, 4338 lb of 18,257-Btu (lower heating value) oil were burned per hr, giving a fuel consumption of 1.04 lb per shaft kwhr, or a thermal efficiency of about 18 per cent (based on the lower heating value of the oil). Full load efficiency of the turbine was 88.4 per cent, while the compressor efficiency, based on the air temperature rise, was 86.6 per cent.

To a steam power plant engineer, a thermal efficiency of 18 per cent is not too impressive until he realizes that no water was used by the plant. The Diesel engineer would expect a thermal efficiency almost twice as high as the 18 per cent attained by Neuchatel, yet he would have difficulty in burning the heavy and cheap oil which the Swiss turbines have burned successfully; and he can have no hope of burning the coal which will be the future fuel for many gas turbines.

The Neuchatel unit proved that the gas turbine can serve as an isolated plant for peak-load or stand-by service. This type of operation requires for economic success that the prime mover be low in first cost, simple in operation and maintenance, quick in starting, and not too particular as to fuel. High thermal efficiency is not important, because the kilowatt hours generated will be few in number, and fixed charges are far more important than operating cost. Where no cooling water is available, as in mountainous or inland locations, and where locally produced gas, oil, or coal are the logical fuels, the simple open-cycle turbine will be worthy of careful consideration.

GE and Westinghouse Power Turbines

The General Electric Co. is now completing the construction of a 4800-hp plant, Fig. 7, designed to burn heavy oil and to be suitable for powering a large locomotive. The Westinghouse Electric Corp. now has under test a 2000-hp unit, Fig. 8, various components of which have

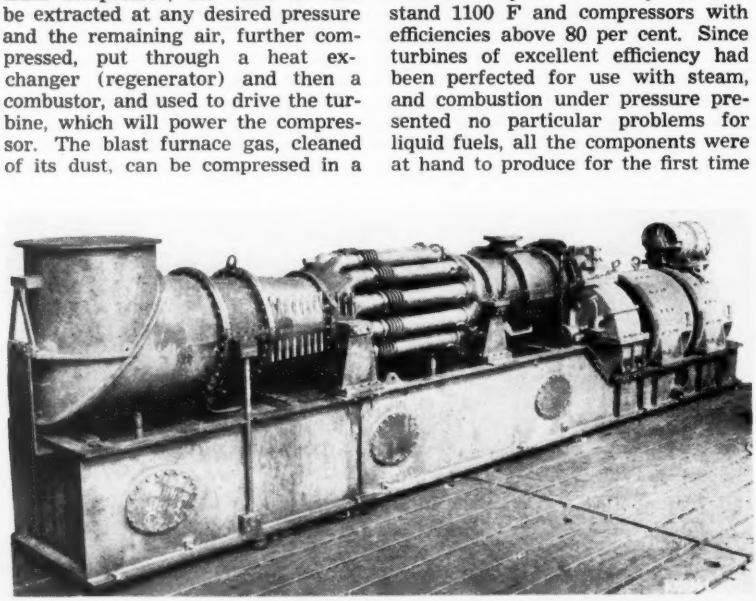

Fig. 8. The Westinghouse 2000-hp experimental oil-fired gas turbine plant

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In dim light, the medieval alchemist pursued his dream . . . transmutation of mercury into gold. Today, atomic energy reverses the dream . . . turns gold into mercury. Thus creative science changes pace to meet the needs of a modern world.
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He'll make a study of operating conditions. Boiler water samples will be analyzed. A treatment program will be mapped out for you. If mechanical feeding is necessary, he'll help you select the proper equipment. And, even then, he won't be through. Periodic call-backs and co-operation with you will help you keep your boilers scale-free, permanently.

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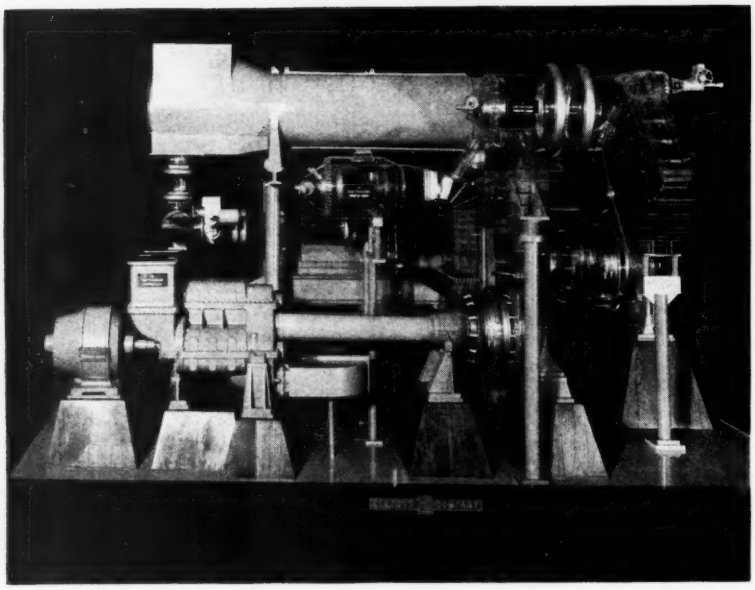

Fig. 9. Model of the Elliott high-efficiency gas-turbine marine power unit

been shown in previous articles of this series. Each of these units shows the strong influence of the jet-propulsion aircraft gas turbines which these companies designed and built during the war. The General Electric unit is similar in arrangement to their TG-180 axial-compressor jet unit, which powered the plane now holding the world's speed record. The Westinghouse unit is similar to their Yankee jet engine, and it is also particularly designed for multiple mounting in a large locomotive. Each unit will burn heavy oil with an efficiency several times higher than any competitive water-free plant that can burn this grade of fuel.

The General Electric turbine will use 1400-F inlet air temperatures, but its two stages will be of the impulse type, with a high temperature drop in each stage. The calculated first stage bucket temperature at the pitch-line is only 1160 F, whereas, if eight reaction stages were to be used, the first row blades would run at 1360 F. Thus the loss in turbine efficiency is expected to be adequately compensated by the gain in cycle efficiency due to the higher temperature. The details of the design (11) of this plant show particular care in reducing pressure loss to a minimum. No regenerator is used, although the turbine and compressor could evidently be rearranged to include a heat exchanger, a large single combustor, and a fly ash separator for use with coal.

The Westinghouse set (12) was built as an experimental turbine designed for long life, compactness, and light weight. A maximum turbine inlet temperature of 1350 F was selected, with a pressure of 75 psia. The compressor uses 20 stages with 12 per cent chromium steel blades, which discharge through 12 cell-type combustors to an 8-stage reaction turbine. Two 1000-hp generators are driven through a single-reduction, double-helical gear. Heavy oil has been successfully burned with air-atomizing nozzles in the combustors. The unit can be brought up to operating speed with 80 kw cranking power in one minute.

Elliott and Allis-Chalmers Power Turbines

An entirely different line of attack was chosen by the Elliott Co. (13) in their experimental marine unit, which was formally demonstrated in July, 1945. This plant was designed for high efficiency and so it employs two Lysholm positive-displacement compressors with one stage of intercooling and a reheater. With turbine inlet temperature limited to 1230 F and a reheat temperature of 1207 F, this unit has shown a thermal efficiency on test of 29.5 per cent, which, at an output of 2500 kw, is a very creditable performance. The plant is designed to drive a propeller, through a reversible transmission from its low-pressure turbine, with the high-pressure Lysholm compressor on the same shaft. The high-pressure turbine drives only the low-pressure compressor.

The Allis-Chalmers Mfg. Co. has produced for the Naval Engineering Experiment Station at Annapolis, Maryland, a plant in which the compressor-drive turbine and the power turbine operate in parallel, with separate combustors and a common exhaust through a large regenerator. The power turbine, shown as Fig. 10 on Page 120 of the July, 1947, issue of POWER PLANT ENGINEERING, has operated successfully at 1500 F, the highest temperature yet attained by any other than aircraft turbines.

American and English gas turbine builders are now turning their attention toward power turbines, as contrasted with the jet propulsion units which occupied their attention during the war. The Brown Boveri Co., operating in neutral Switzerland, has been continuing to pioneer in high-efficiency, moderate-temperature central station and industrial power plants. Their plants, all with a top temperature of 1100 F, range in size (8) from a 1200-kw, 23 per cent

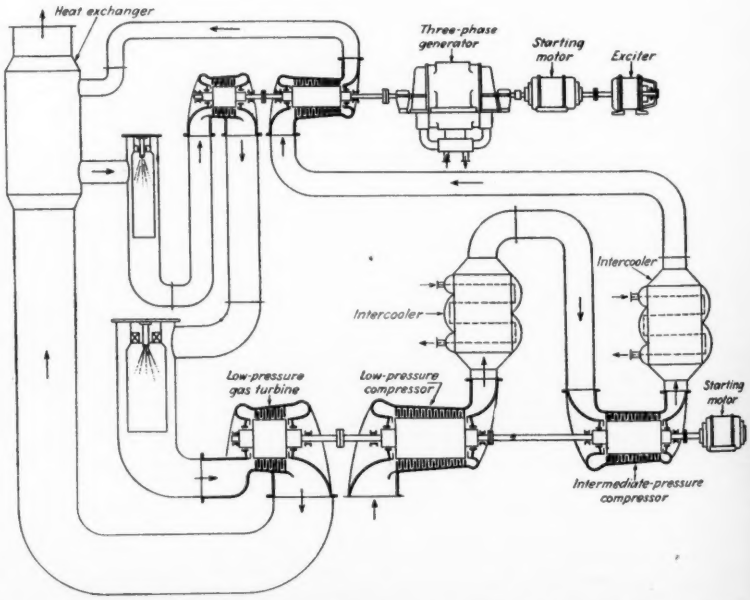

Fig. 10. Arrangement of the Brown-Boveri central-station unit for Burcharest, Rumania, on the test floor at Baden

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This is the first of a series of advertisements briefly outlining the important elements that go to make up a COTTRELL installation. Only long experience coupled with highest engineering ability, can assure the proper combination of these elements into a COTTRELL installation best suited to *your particular requirements*!

Basically, a Cottrell Precipitator consists of three major divisions each in turn consisting of many separate elements . . .

1. THE ENERGIZING SYSTEM, as its name implies, is the portion of the unit wherein the power is brought in, the voltage stepped up, then rectified to provide the unidirectional high voltage current supply for the Electrode System.

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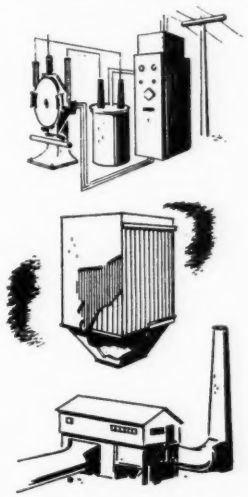

Each of these three major divisions, together with their many individual parts, must be carefully engineered into ONE integrated and precisely-balanced unit to provide the successful and continuously-operating COTTRELL Precipitator. This series will take these major units apart to show in greater detail how the individual parts function and the varying types of design and construction. Watch for them.

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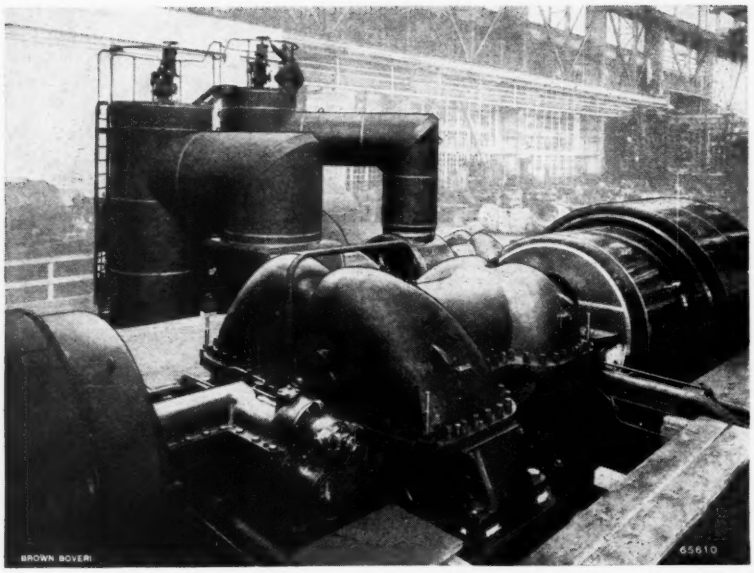

Fig. 11. View of a 10,000-hp Brown-Boveri unit assembled for test at Baden

thermal-efficiency (at the generator terminals) unit for Alexandria, Egypt, to a 40,000-kw combination for operation at Beznau, Switzerland. This largest of all present-day gas turbine is intended primarily for winter baseload service when the run-off on a hydro system is low. The combination of low ambient air temperature, cold water for intercooling, and regeneration will result in a thermal efficiency of about 34 per cent.

Brown-Boveri and Escher-Wyss Units

A 10,000-kw single-reheat, double-intercooler regenerative plant for Lima, Peru, is expected to reach a thermal efficiency of 27.5 per cent with 86 F ambient air. This type of plant is likely to find usefulness in central stations, and so a diagram is given in Fig. 10 which shows the arrangement of its components.

The closed-cycle plant has been the subject of much discussion, but the 2000-kw plant built and tested by the Escher-Wyss Co. of Zurich, Switzerland is the first of this type to go into actual service. Tests made on December 13 and 14, 1944, by Professor Quiby, of the Swiss Federal Institute of Technology, showed a specific fuel consumption of 0.614 lb of 18,450 Btu oil (lower heating value) per kw hr at the generator terminals, which represents a thermal efficiency including auxiliaries of 31.6 per cent. When it is realized that the best steam plant efficiency yet reported is the 31.7 per cent of the Port Washington, Wis., 80,000-kw reheat steam turbine plant, it is evident that the gas turbine has come a long way in a relatively short time.

Present Status of Gas Turbine Power Plant

To summarize the present position of the gas turbine plant as a power generator, it is apparent that open-cycle combinations can be built for output up to 25,000 or 30,000 kw, by using multiple compressors, intercooling, and reheat. Much larger units can unquestionably be built if the closed cycle is used. Where power requirements range from 2,000 to 20,000 kw, where water is scarce, and where heavy oil is the economical fuel, the gas turbine is a logical answer. When the coal-burning gas turbine plant becomes a reality, many other applications will be opened up, such as mine-mouth plants, lake and coast-wise shipping, and locomotives.

Space has not permitted an adequate treatment of the problem of part-load operation of gas turbine plants. An excellent discussion of this subject was given by Rohsenow and Hunsaker (15) for a two-shaft plant such as that installed by Allis-Chalmers at Annapolis. This type of plant, with a 60-cycle alternator driven at constant speed by the power turbine, is the most promising for public utility service, since it offers a compromise between constant temperature, variable speed operation which gives optimum part-load efficiency, and constant speed operation which is necessary to maintain constant frequency.

IV. Plants to Produce Both Power and Steam for Process, Heating, Etc.

It is in this field that the gas turbine is most promising to industrial plants, for heat is even more important than power to many industries. By making use of intecoolers, with several compressors in series, and by using the turbine exhaust for waste-heat boiler operation, very effective combinations can be obtained. The gas turbine possesses the advantage of throwing away all of its unusable heat at relatively high temperature levels, which means that much of it can be reclaimed in the form of steam or hot water. Details of various combinations of gas-turbine and heat absorbing components, for industrial application, will be given in the next and concluding article of this series.

(To be continued)

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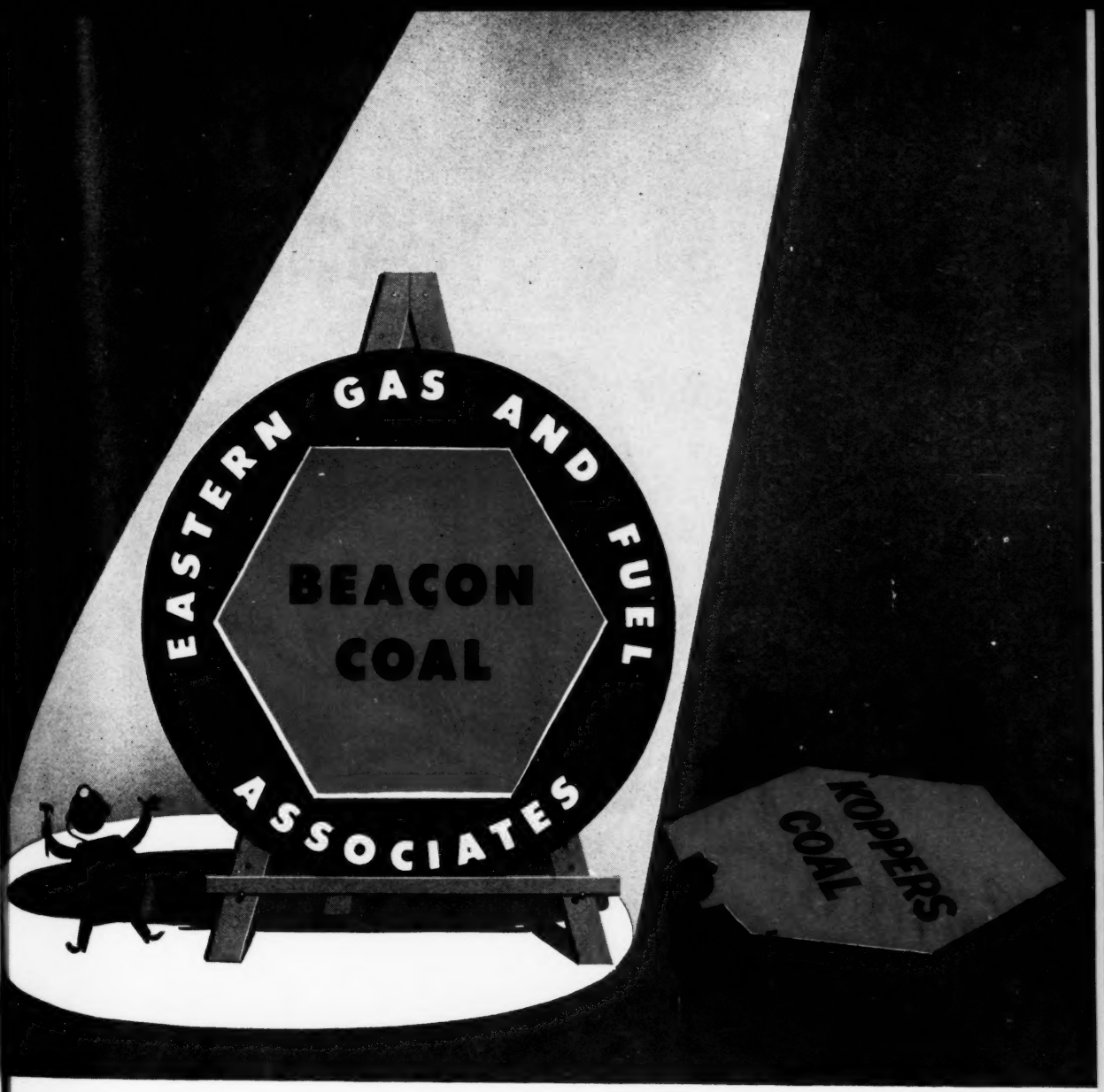

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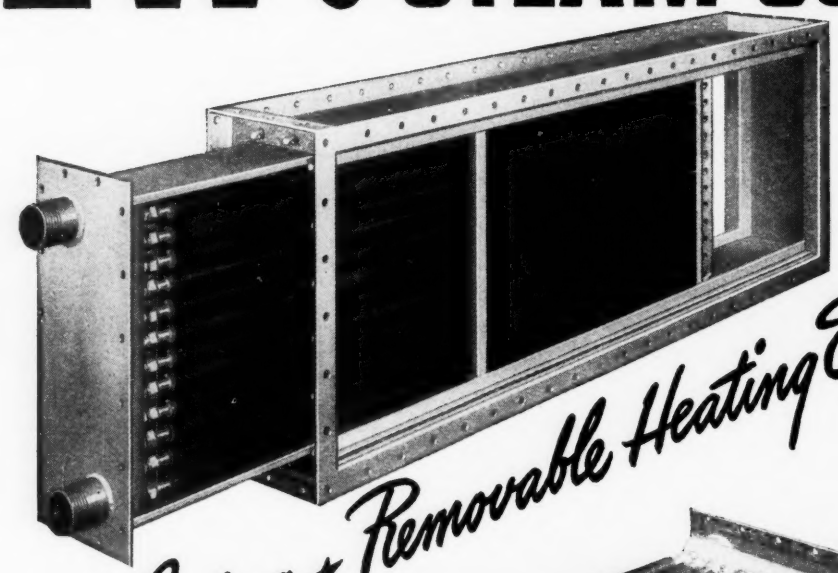

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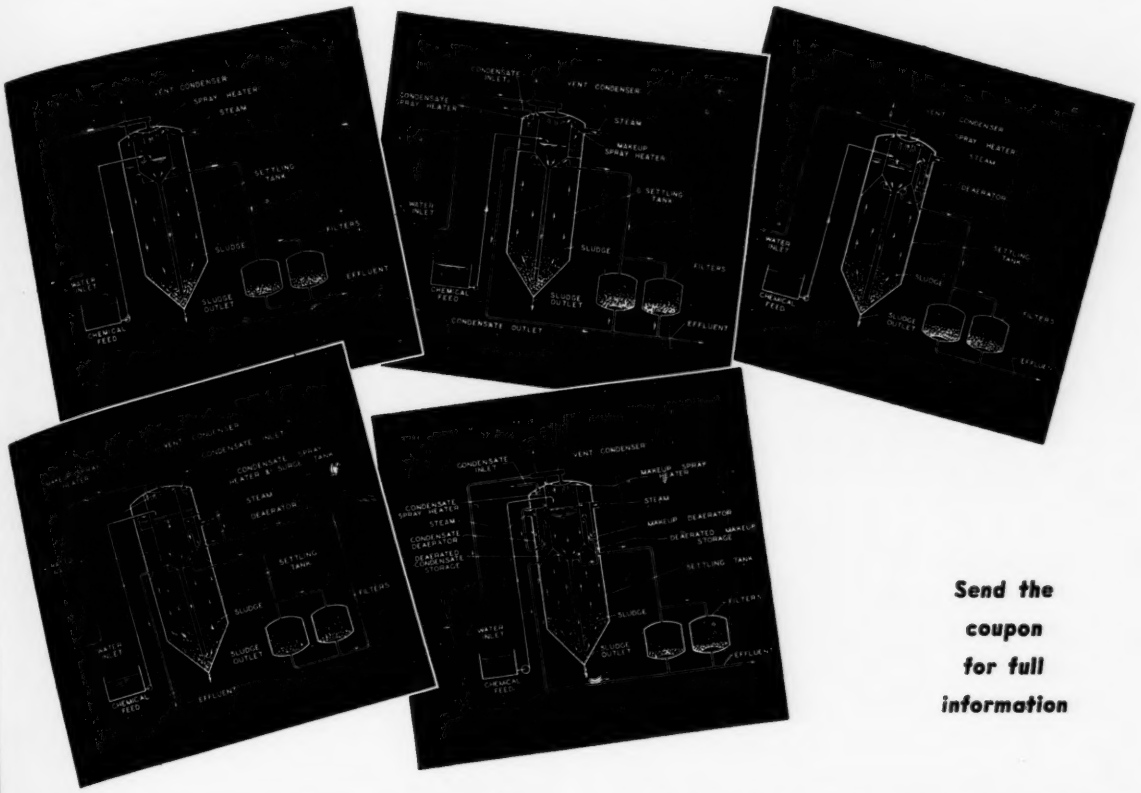

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POWER FROM WASTE WOOD FOR WELDWOOD

CONVERSION OF waste wood into steam power, has just been realized by the Algoma, Wisconsin mill of the United States Plywood Corp.

The steam for the new 750-kw turbine generator is supplied by three 500-hp water tube, water wall boilers, with operating pressure of 200 psi, using natural draft. The three boilers will carry the extreme peak load of the plant which is anticipated for only a few months of the year. This will allow repairs on any one of the boilers at any time except during this extreme peak.

Each boiler has a dutch-oven furnace that efficiently burns "hog fuel", reduced to chips by special knife and hammer type machines. The wood waste is conveyed on a continuous system through the "hogs" and directly into the dutch-oven furnaces.

Planer shavings and sawdust are picked up from the production machines by a network of suction pipes which pneumatically convey the material to the large cyclone-type separators on top of the power plant building. From the separator the solid wood fuel drops by centrifugal force and gravity to the furnace.

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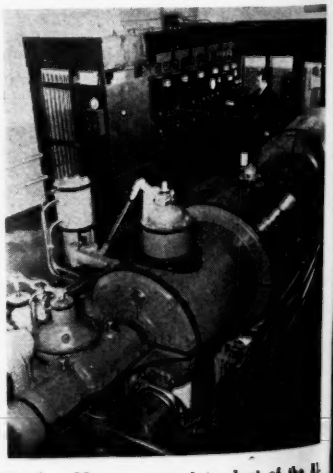

Gordon Mercer, superintendent of the Algoma, Wisconsin, plant of the United States Plywood Corp., throws the switch on the master controls of the new power plant, supplying electric energy for all Algoma operations

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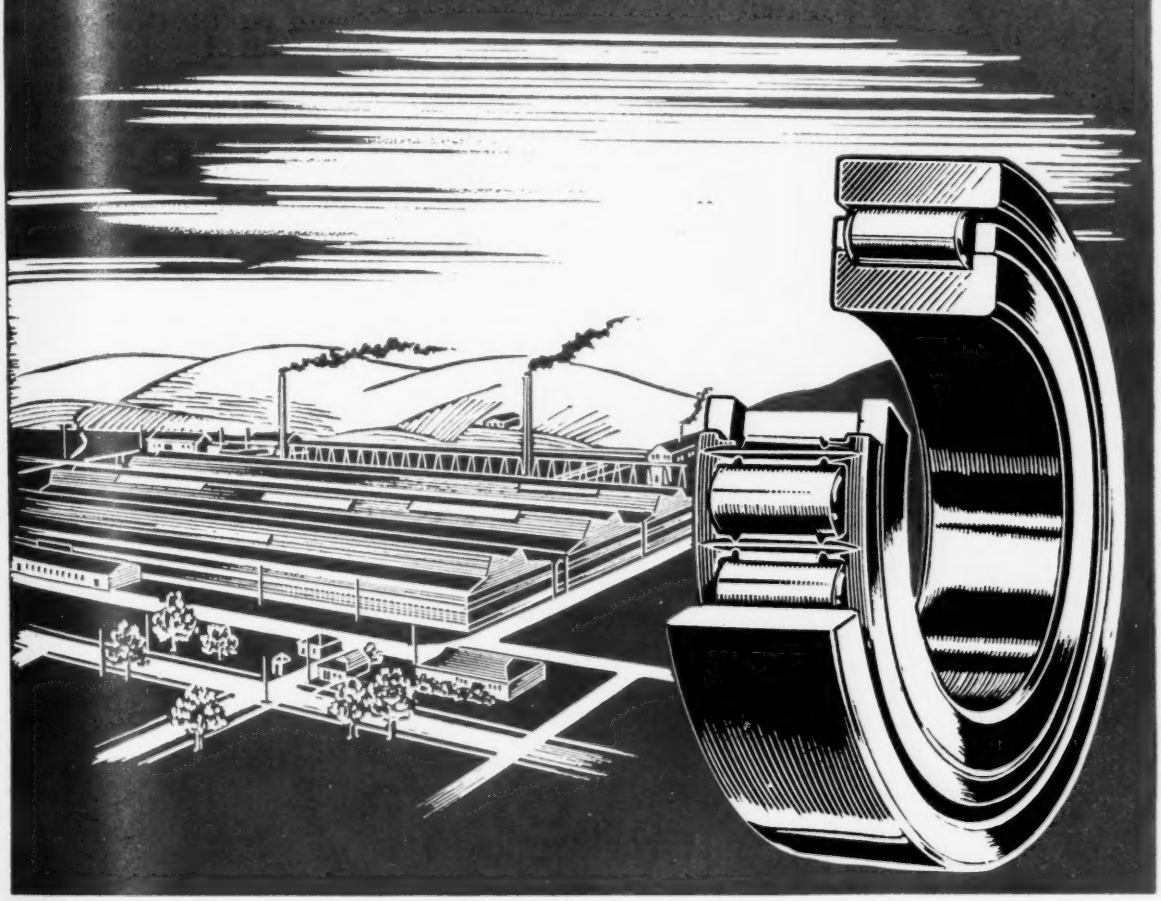

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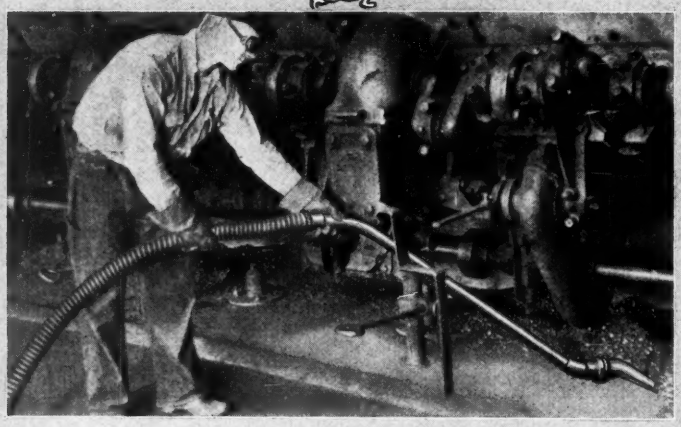

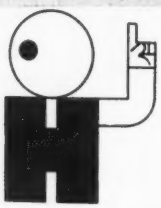

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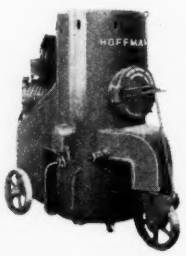

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The post-war possibilities of cold treating of metals and other materials used in industry are extremely promising. With wartime pressure relaxed, further research and experimentation in cold treating promises to develop limitless applications in industry.

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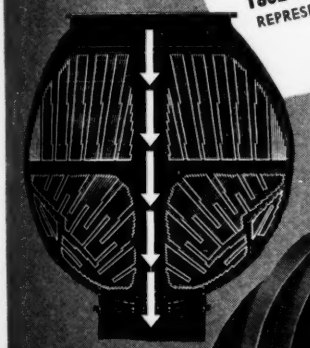

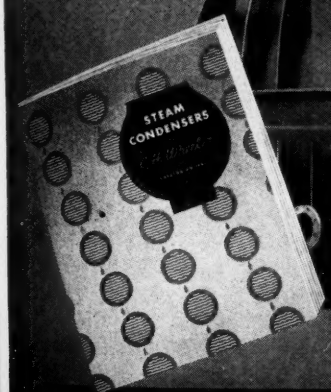

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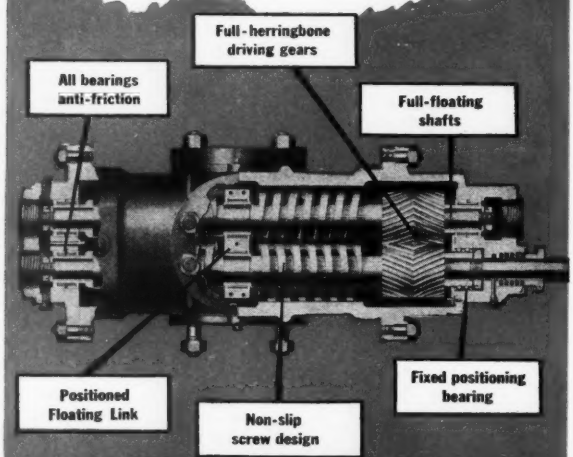

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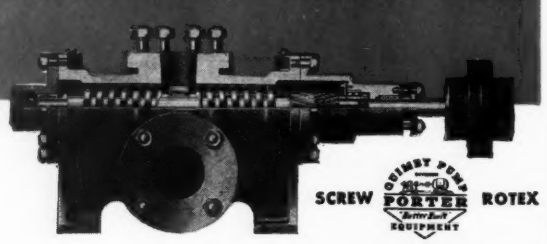

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EXPLOSIVE DISSOCIATION, a new process for exploding cereal grains and legumes by means of compressed air or other gases has been announced by the Midwest Research Institute of Kansas City, Mo. The procedure has obtained a preferential segregation of husks, bran, germ and endosperm in wheat, grain sorghums and oats. Grain, under pressure, when fed through a nozzle in a pipe, is shattered by the instantaneous release of pressure within the pockets of the grain. While the apparatus compares in some respects with that used to obtain the flash pulverization of coal, the action of the grain is drastically different. In the explosive dissociation process, by varying pressures and pressure contact periods, almost any desired end point can be obtained. Patent rights have been applied for in the name of the regional industrial research organization. Plans are under way for the construction of a $100,000.00 pilot plant at the Institute in cooperation with cereal processors to test the procedure on a commercial scale.

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A NEW SPENCER stereoscopic shop microscope is specially designed and built to expedite numerous industrial operations where minute details must be closely observed. Developed to improve quality control, the microscope is exceptionally useful in varied industrial operations: injection jet drilling, precision grinding, hand broaching, fine engraving, watch escapements, small parts inspection, die sinking, lens mounting and many other toolmaking, fabricating and inspection processes. Where minute details are involved, magnification is desirable to assure precision in production and inspiration without undue eyestrain. Yet magnification alone does not solve the problem. Depth perception must not be lost. Actually a microscope for each eye, the new Spencer shop microscope provides both stereoscopic vision and magnification of minute parts and details. The magnified image is seen right side up and not inverted, so that operations can easily be performed under the instrument.

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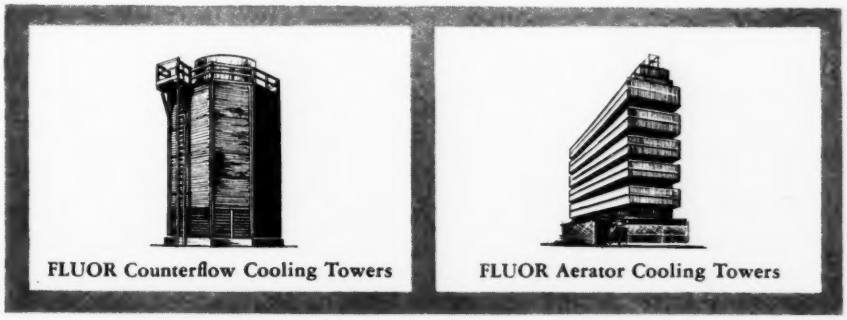

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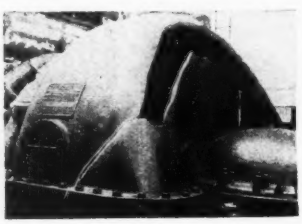

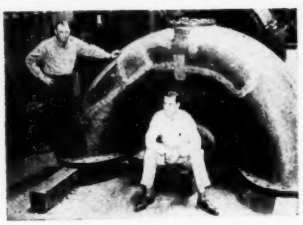

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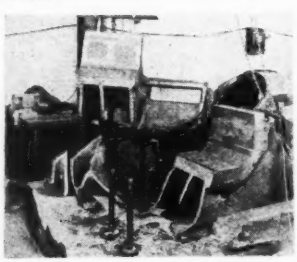
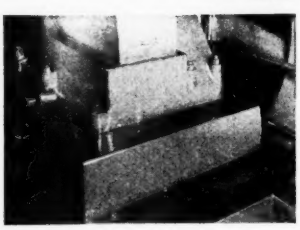
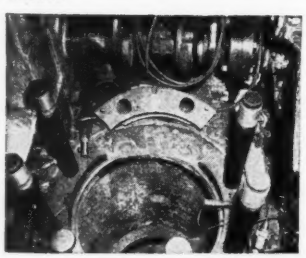
Before **After**

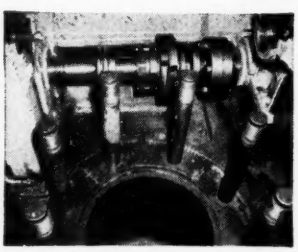




32 IN. DIA. DIESEL ENGINE BLOCK

Before **After**





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COMING EVENTS

Water Conference—The 8th Annual Water Conference of the Engineers' Society of Western Pennsylvania will be held in the William Penn Hotel, Pittsburgh, Pa., on November 12, 13, and 14.

Notice—Midwest Engineering and Power Exposition originally scheduled for November 15 through 20 has been cancelled.

Chemical Exposition — Twenty-first Exposition of Chemical Industries; to be held in New York City, December 1 through 6, headquarters at Grand Central Palace.

ASME—Annual Meeting of the American Society of Mechanical Engineers; to be held in either New York City or Atlantic City, N. J., December 2 through 5. Headquarters Chalfonte-Haddon Hall.

SESA—The annual meeting of the Society for Experimental Stress Analysis; to be held December 4, 5 and 6 at the Hotel Pennsylvania, New York City.

Materials Handling — Second Materials Handling Exposition, to be held January 12 through 16, 1948, with headquarters at Cleveland Public Auditorium, Cleveland, Ohio.

Refrigeration and Air Conditioning Exposition — Fifth All-Industry Exposition; to be held January 26 through 29, 1948, with headquarters at Cleveland Public Auditorium, Cleveland, Ohio.

Air Conditioning Exposition—Eighth International Heating and Ventilating Exposition, to be held in New York City, February 2 through 6, 1948, headquarters at Grand Central Palace.

Obituaries

PETER E. FLUOR

PETER E. FLUOR, president and chairman of the board of directors of the Fluor Corp., Ltd., Los Angeles, passed away recently at his home in Anaheim, Calif. Mr. Fluor was 52 years old.

Born in Oshkosh, Wis., in 1895, he came to California in 1912. He served in World War I as a Lieutenant in the Army Air Force. Much of his army career was spent as a pilot on active duty in France. It was after his discharge that he entered the construction field.

Long active in local and national oil circles, he numbered among the many organizations to which he belonged the American Petroleum Institute, California Natural Gasoline Association and the Western Oil and Gas Association.

Survivors are his widow, Margaret; one son, John Robert; two daughters, Mrs. Elizabeth Taylor of Evanston, Ill., and Margaret Ann, a student at the University of Southern California; two brothers, Fred C. Fluor and J. S. Fluor, Jr., of Santa Ana; two sisters, Mrs. Esther Gardner of Santa Ana and Mrs. Elsie Daigle of Anaheim, and three grandchildren.

W. V. HARTMANN

WILLIAM V. HARTMANN, 75, vice-president in charge of marketing for the Gulf Oil Corp., died recently.

Mr. Hartmann was in the oil business for almost 60 years, 43 of them with Gulf. He became a salesman for that company in 1903 in New York, and in 1905 was made assistant sales manager in Pittsburgh. He was promoted to sales manager in 1912 and became a vice-president in 1929.

He was born in Cincinnati. From 1888 to 1892, he was a clerk for Alexander McDonald & Co., Cincinnati, which was merged with Standard Oil in 1892. From

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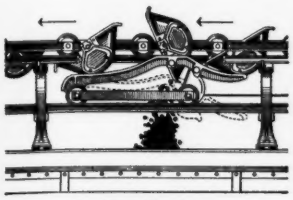
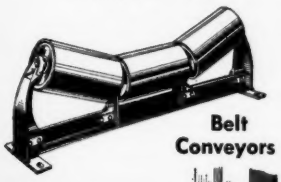
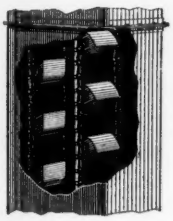


Bucket Carriers



Belt Conveyors



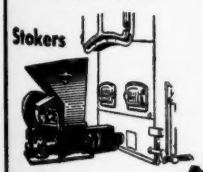
Bucket Elevators

Bulk-Flo

Screw Conveyor

Skip Hoist

Coal Crusher

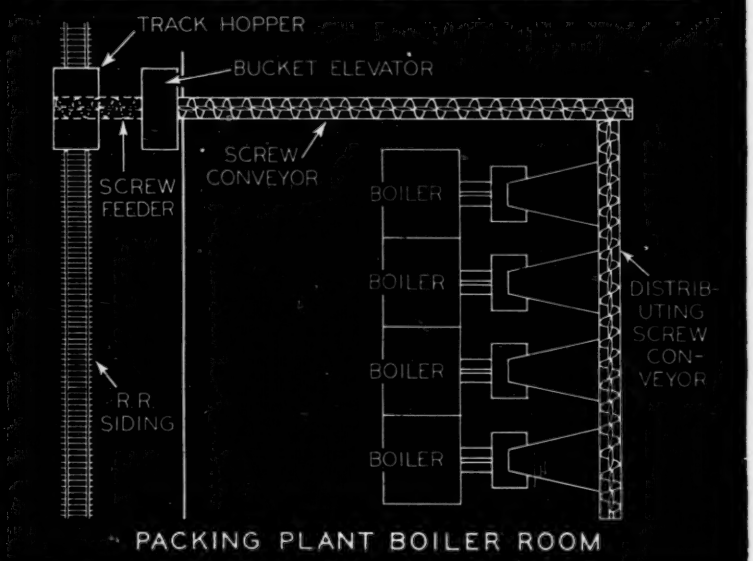


Stokers

Car Dumper

Weigh Larry

CUTTING COSTS WITH CONVEYORS



The Boiler Room Was a "Gold Mine"

NOTE to plant men who need to cut expense corners to combat high material and labor costs: your boiler room may be a "gold mine" for savings.

With the packing plant boiler house coal handling layout shown above, a problem was solved by a combination of Link-Belt units. Through a screw feeder, bucket elevator, screw conveyor and distributing screw conveyor, coal is handled from gondola cars to stoker hoppers. The services of only one man are required for unloading and maintenance. There is no coal dust problem.

The best team efficiency occurs when each man is a star at his own position. On the Link-Belt conveyor team are stars for any conveyor function, with a top-flight coach (the Link-Belt engineering department), to coordinate the overall result. Link-Belt makes Screw Conveyors . . . Bulk-Flo Elevator-Conveyors . . . Overhead Trolley Conveyors . . . Bucket Elevators . . . Skip Hoists . . . Belt Conveyors . . . The Sidekar-Karrier . . . Apron Conveyors . . . The Peck Carrier . . . Flight Conveyors . . . and many others.

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STEAM ENGINE

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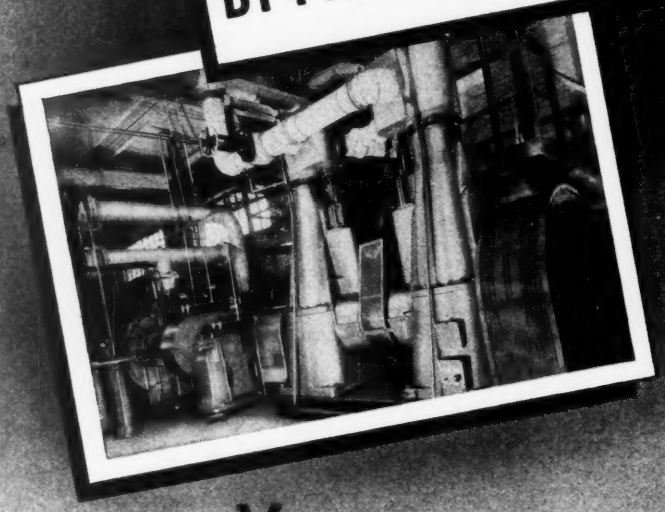

Make your STEAM do two big jobs . . . eventually one of them at little or no cost. With proper heat balance your steam can provide—FIRST, power for driving equipment, and SECOND, heat units needed for processing or heating.

Use boiler steam to run a Troy-Engberg Steam Engine. THEN use the exhaust in your heating or processing lines. Drive your pumps, stokers, generators, blowers or compressors with By-Product Power. Use a Troy-Engberg Steam Engine as a reducing valve and your power cost saving will pay for the engine in a very short time.

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STEAM ENGINES • GENERATING SETS • GENERATORS

1893 until he joined Gulf Refining Co. Mr. Hartmann was Standard's agent in Evansville, Ohio.

Mr. Hartmann was a member of the American Petroleum Institute, of which he was elected a director in 1934; the Pittsburgh Athletic Association; the Fox Chapel Golf Club, and the Homewood Cemetery Association, both in Pittsburgh.

Surviving are his wife, Mrs. Elizabeth Hopkins Hartmann, and two sisters, Mrs. C. E. Mehlhope and Mrs. T. A. Petsche.

EDWARD C. BOWERS

EDWARD C. BOWERS, 66, a member of the executive board of the Wickwire Spencer Steel Co., died recently at the Yale Club. Mr. Bowers resigned in 1943 as president of the company. He was a director and member of the executive committee at his death.

Mr. Bowers was born in Westfield, N. J. He was graduated from Yale in 1903. He joined the Wickwire Co. in 1911 and later became manager of the Iron River, Mich., plant. He became president of the company in 1926. His wife, Mrs. Dorothy Schroeder Bowers, of 229 East Seventy-ninth Street, survives.

T. R. AGG

T. R. AGG, Dean of Engineering at Iowa State College, died recently.

For a number of years he was on the staff of the University of Illinois. In 1913 he joined the staff at the Iowa State College, where he became Dean of Engineering in 1932.

Dean Agg was active in the work of many technical and professional societies and groups. He received the Marston Medal award posthumously, the highest award of the Division of Engineering at Iowa State College.

FRANK OAKES ELLENWOOD

PROF. FRANK OAKES ELLENWOOD, 68, professor of heat-power engineering at Cornell, died recently in Strong Memorial Hospital, Rochester, after a short illness.

A native of Little Hocking, Ohio, he received the degree of bachelor of arts in mechanical engineering from Stanford University in 1904 and his M.E. there in 1922. He was an instructor in mechanical engineering at Stanford from 1908 to 1911, when he came to Cornell as assistant professor of engineering. In 1915 he was made a professor and in 1940 was appointed head of the department of heat-power engineering. He was made John Edson Sweet professor in 1941.

Professor Ellenwood was president of the Cornell chapter of Phi Kappa Phi honorary fraternity and was associated with the ASME, SPEE, ASRE, AAAS, Sigma Xi, and Tau Beta Pi.

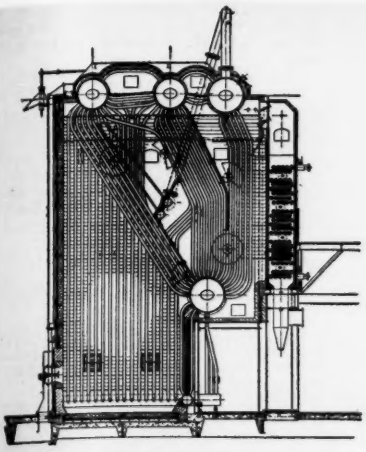
President in 1917 of the Bryant Park Civic Association, he has been for many years a member of the board of trustees of the First Unitarian Society. He was also a member of the Country Club of Ithaca. Throughout his long career, he had been an engineering consultant for leading U. S. engineering and manufacturing firms.

Professor Ellenwood leaves his wife, Cecilia Freeman Atherton Ellenwood; two daughters, Mrs. Warner Hammond of Syracuse and Mrs. Prince McGuyre of Wichita, Kan., and three grandchildren.

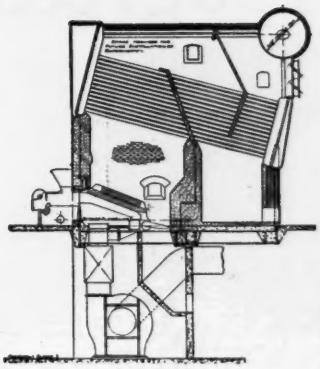
DR. W. E. WICKENDEN

DR. WILLIAM E. WICKENDEN, retiring president of the Case School of Applied Science in Cleveland, died recently in Peterboro, N. H.

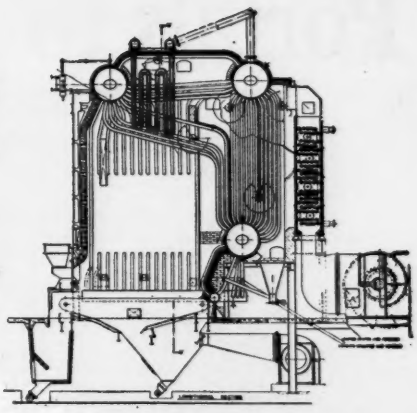
Born in Toledo, Ohio, on Dec. 24, 1882. Denison University, B.S. 1904; graduate student, University of Wisconsin, 1905-07; (hon.) Lafayett, Doctor of Engineering, 1926 Denison, Doctor of Science, 1928. Assistant Professor of Electrical Engineering, University of Wisconsin, 1909-14; Associate Professor, 1914-18; personal manager, Westinghouse Electric Co., N. Y., 1918-21; assistant vice president of Amer-



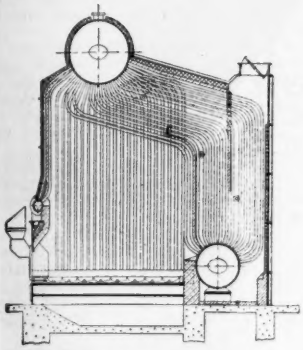
4 Drum Water Tube Boiler



Horizontal Cross or Long Drum Water Tube Boiler

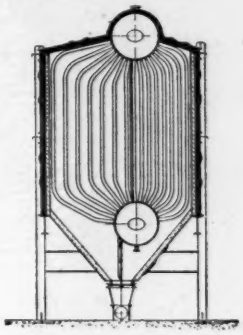


3 Drum "B" Type Water Tube Boiler



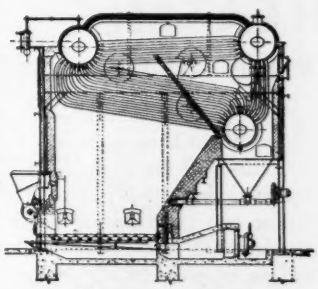
Standard 2-Drum Unit

WICKES BOILERS



Wickes 2 Drum Waste Heat Installation

Boilers and pressure vessels designed and manufactured in our plant are converting steam loads into industrial energy in scores of important installations the world over. We have the engineers, manufacturing facilities, and skilled workmen to fill your requirements for boilers of any type up to 250,000 lbs. steam per hour and 850 psi. We also perform all types of heavy welded plate fabrication for oil, chemical, paper, and other industrial use. Send us your problems for expert consultation and recommendation. No obligation, of course.



3 Drum Low Head Water Tube Boiler

THE WICKES BOILER COMPANY

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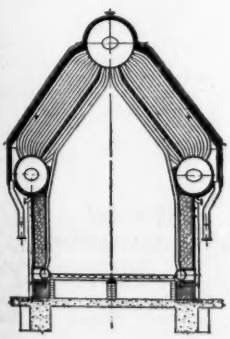
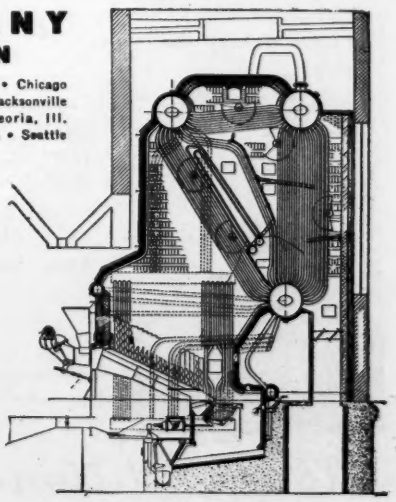
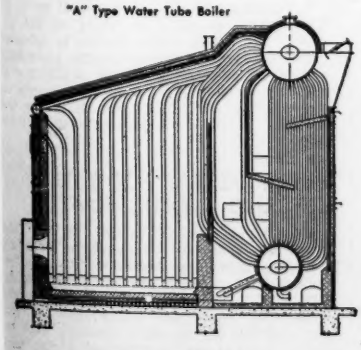
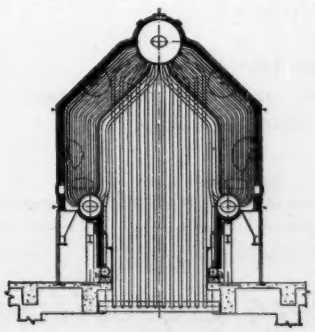


"A" Type Water Tube Boiler





2 Drum Water Tube Boiler



Crown "A" Type Water Tube Boiler

3 Drum Water Tube Boiler

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Assembled here you'll see over 350 arresting displays and demonstrations of the newest and best ways to heat, ventilate and condition air in all types of industrial plants. Here in less than a week's time you can study and compare first-hand the relative merits of everything from complete units to maintenance supplies—in the light of your office and factory needs . . . discuss your problems and plans with technical attendants at the booths—men on hand expressly to help you with your problems, tell you what you want to know to keep abreast of the trends and practices in these active fields.

The wealth of worthwhile stimulating ideas, information and contacts at this exposition may save you much time, trouble and expense.

Plan now to attend—
have your associates come, too.
Mark the date.

Under Auspices of
American Society of Heating & Ventilating Engineers

8th Air Conditioning Exposition

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NEWS *from* THE FIELD

WATER CONFERENCE

Hotel William Penn
Pittsburgh, Pa.

WEDNESDAY MORNING, NOVEMBER 12TH

"Experiences with Frequent Acid Cleaning of Power Plants," by S. K. Adkins, Omaha Public Power District.

"Removal of Silica Deposits from Steam Turbines by Caustic Soda," by I. B. Dick, Consolidated Edison Co. of New York.

AFTERNOON

"The Use of X-Rays in Water Problems" by Dr. L. A. Burkhardt, Allis-Chalmers Mfg. Co.

"The Biological Reactions of Polluted Waters on Copper Bearing Alloys," by C. O. Evans, Phelps Dodge Copper Products Corp.

THURSDAY MORNING, NOVEMBER 13TH

"Treatment of Brackish Boiler Feed Water," by O. M. Elliott, Sun Oil Co.

"The Heat Exchange Method of Oxygen Determination in Boiler Feedwater," by J. F. Sebald, Worthington Pump & Machinery Corp.

AFTERNOON

"Silica Removal by Means of Ion Exchange Resins," by A. V. Alm, American Cyanamid Corp.

"Some Practical Aspects of De-Ionization," by Joseph Thompson & F. X. McGarvey, Resinous Products & Chemical Co.

A Review of Field Performances on Methods of Removing Silica as discussed at symposium held at 7th Water Conference.

FRIDAY MORNING, NOVEMBER 14TH

"Liquid Chemical Feed Systems," by R. T. Sheen, Milton T. Roy Company.

"Automatic Control in Corrective Water Treatment," by W. N. Greer, Leeds & Northrup Company.

AFTERNOON

"Pennsylvania's Stream Pollution Program," by L. S. Morgan, Department of Health, State of Pennsylvania.

"How Some Troublesome Waste Water Problems were Solved," by A. C. Embshoff, Infilco Inc.

"Engineering Studies for Industrial Waste," by G. A. Rohlick, University of Wisconsin.

DR. MATHEWSON RECEIVES ASM MEDAL

DR. C. H. MATHEWSON, Professor of Metallurgy at Yale University, was recently elected to receive the Gold Medal of the American Society for Metals for 1947.

According to the announcement by W. H. Eisenman, national secretary of the Society, the ASM Gold Medal is awarded "for outstanding metallurgical knowledge and great versatility in the application of science to the metal industry, as well as exceptional ability in the diagnosis and solution of diversified metallurgical problems."

SUPER METALS FOR TURBO-JET AND ATOMIC POWER

A NEW GROUP of "super metals" and ceramics soon will be available for man's new high-powered machines, the turbo-jet, rocket and atomic energy power plants, Clyde E. Williams, director of Battelle Memorial Institute, Columbus, O., told The ASME at its Fall meeting here recently. They will withstand higher temperatures and pressures than materials

why

more cooling requirements and more operating conditions are served than with any other make

ROSS

STANDARD "CP" COOLERS

● "Standard", in any product, naturally implies more favorable cost and more favorable delivery. That's so with Ross Standard "CP" Coolers . . . *PLUS* the fact that, where necessary, mass produced standard parts may be specially assembled and arranged for highest heat transfer under *your own conditions.*

You'd think, then, that practically *ANY INDUSTRY,* requiring circulation of oil, water and other fluids for heat removal, would have little choice to make. That's right! Both machinery builders using coolers as original equipment, as well as industrial consumers making their own installations, show a great preference for this all-purpose Ross unit. They continually select the "CP" design, knowing that both normal and special problems of installation, operation and maintenance can be regularly served without the need for high cost, special engineering and fabrication.

For your requirements, do as thousands have done. Call in a Ross Heat Exchange Engineer to make an analysis and recommendations.

ROSS HEATER & MFG. CO., INC.

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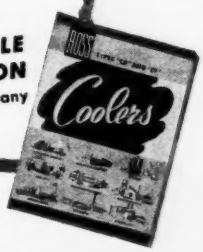
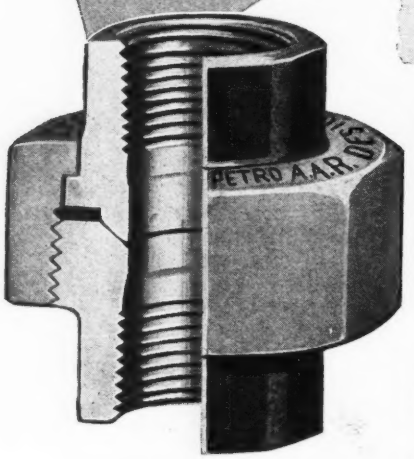


Ross equipment is manufactured and sold in Canada by Horton Steel Works, Ltd., Fort Erie, Ontario

there is

ENDURANCE

in FORGED STEEL UNIONS



SIZES ⅛" TO 3"

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AMERICA'S MOST UNIVERSALLY USED UNION

PETRO unions have integral steel to steel seats. Made to A. A. R. design. 600 lbs. S.W.P.-2000 lbs. C.W.P. Extra heavy ends and nut with nut threads that are permanently lubricated. The seats are machined and cold rolled.

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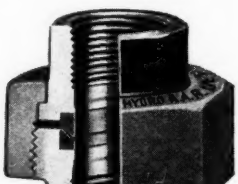
Pressures from a vacuum to 3000 lbs.: Temperatures from 100° below zero F. to 1000° above zero F.: On Steam, Gas, Air, Oil, Gasoline, Ammonia, Chemicals, and any service in which Steel or Wrought Iron Pipe is Used.

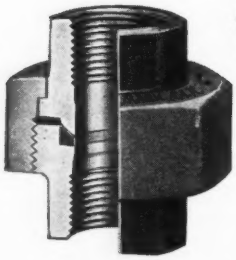
Hydro

THE ONLY FORGED STEEL UNION WITH TWO BRONZE SEATS

Made to A. A. R. design. 600 lbs. S.W.P.-2000 lbs. C. W. P. HYDRO unions have extra heavy ends and nut, with the nut threads permanently lubricated. The bronze seats are completely fused to the steel and are then machined and cold rolled.



SIZES ¼" TO 3"



SIZES ¼" TO 3"

Mark A.A.R.

AMERICA'S FIRST STEEL UNION

The MARK A. A. R. unions have bronze to steel seats. Made to A. A. R. specifications. 600 lbs. S. W. P.-2000 lbs. C. W. P. MARK A. A. R. unions have extra heavy ends and nut with the nut threads permanently lubricated. The bronze seat is completely fused to the steel and then machined and cold rolled.

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ORIGINATORS AND PIONEERS OF FORGED STEEL UNIONS

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now available, he said, and so will offer potentialities for power generation that are "simply staggering."

The present program to develop new and revolutionary forms of power generation and transportation for purposes of national defense, spearheaded by the Army and Navy, "will keep America safe from attack by an aggressor nation and contribute to strengthening national economy," Dr. Williams declared. It will constitute a great force for world peace by "giving America the strength and confidence she needs to maintain the peace."

NEW ASA STANDARDS LISTING

AN ENTIRE new listing of its 874 standards is now available free of charge at the American Standards Association and may be obtained from their office, 70 East 45th Street, New York 17, N. Y., P. G. Agnew, vice president of the American Standards Association announced today.

Under the new price listing a complete set of all American Standards comes to $200.00 and a complete set of all American Safety Standards costs $32.50 a set.

PRESSURE VESSEL RESEARCH PROGRAM

PROGRESS in the pressure vessel research program costing $75,000 a year, which has been undertaken by the Welding Research Council of the Engineering Foundation, was reported yesterday by Dr. A. B. Kinzel, chairman of the board of the Foundation.

"The program aims at developing information and data which will lead to better, safer and more economically constructed pressure vessels," said Dr. Kinzel.

The study of pressure vessels, industry's widely used, giant-sized cousins of the kitchen pressure cooker, is one of the newest and largest projects to be sponsored by the Welding Research Council.

Walter Samans of the Sun Oil Co. continues as chairman of the project's general committee which is made up of 87 representatives of manufacturers and users of pressure vessels, insurance companies, educational institutions and branches of the U. S. government. The principal financial support is being provided by interested manufacturers and users of pressure vessels.

The program, which was instigated by the Welding Research Council, secured the hearty support of industry and the cooperation of several engineering societies. The studies cover four phases of the problem, design, fabrication, and testing and inspection.

WHICH WAS THE FIRST AIR-CONDITIONED FACTORY IN THE COUNTRY?

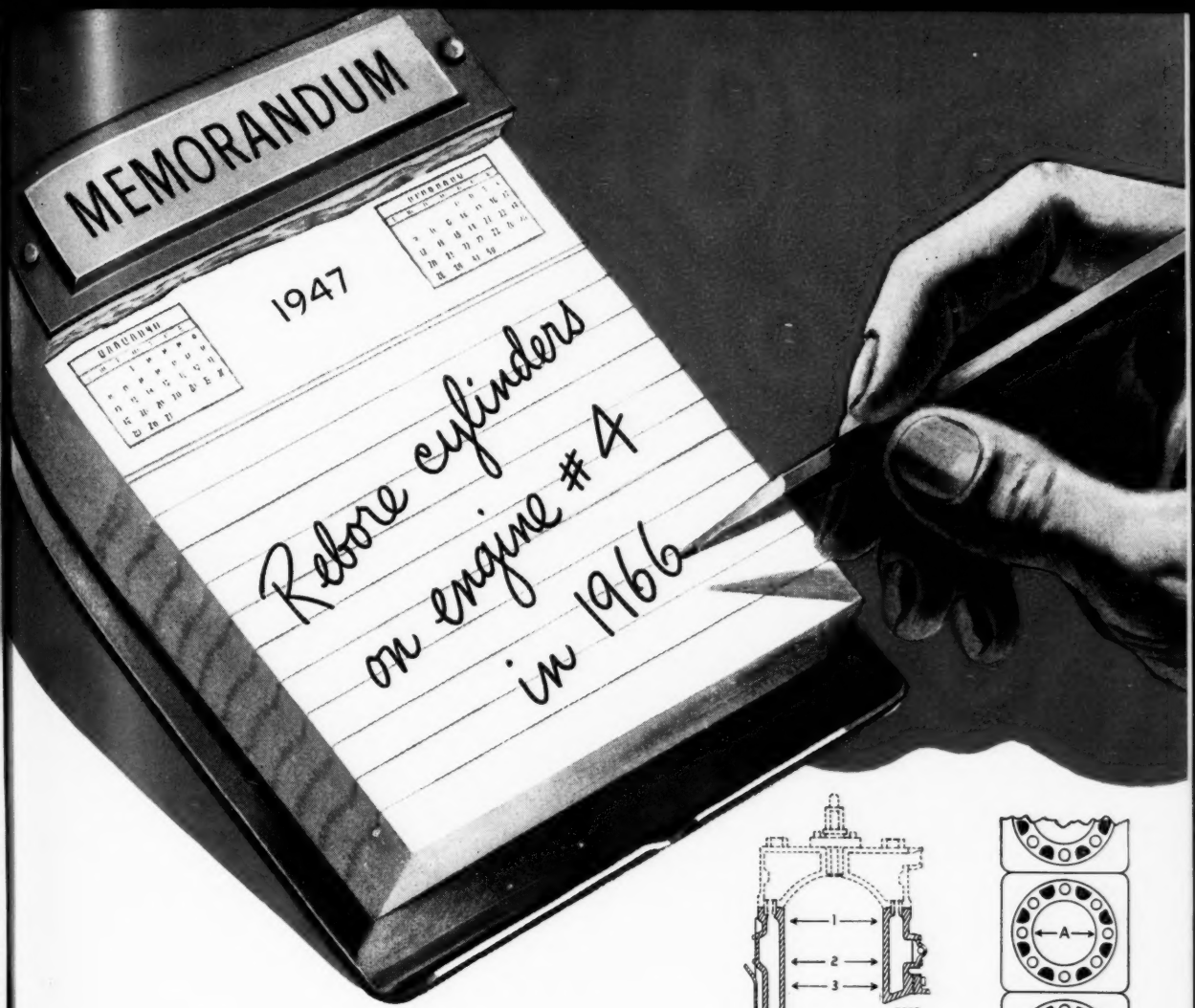
THIS QUESTION is being asked by the Refrigeration Equipment Manufacturers Association, which is seeking to discover and recognize the first establishments in the United States to have adopted air conditioning.

The refrigeration and air conditioning industry today is said to be the fastest growing industry in the world. The association is compiling the early history of the industry and awarding scrolls to the first users of mechanical refrigeration for comfort air conditioining, recognizing them as pioneers.

Factories which installed air conditioning systems early and believe they may have pioneered, should contact REMA care of Theodore R. Sills & Co., 39 S. La Salle Street, Chicago 3, Ill. The association will want the date and extent of installation and a very brief description of the type of equipment.

FUEL SAVINGS BULLETIN

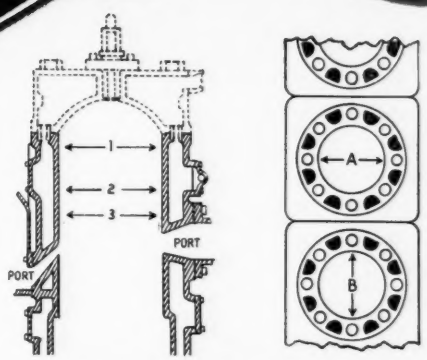
ANSWERING HUNDREDS of practical questions on fuel saving practices and fuel conservation measures, the Bureau of



No cylinder reboring for 19 more years—114,000 hours! And that, on top of four years' operation—24,000 hours to date! That's the indicated service with Nonpareil HD Diesel Oil in a Fairbanks-Morse Model 33-E-16 engine at a midwest power plant.

The estimate of 23 years without cylinder reboring is based on the low wear during the first 24,000 hours of operation. Cylinder wear figures in the table at right show that with Nonpareil HD the maximum wear was only .014 of an inch. This is only half the normal wear in Diesel operation.

These figures prove that this heavy-duty, detergent oil can greatly increase the life of Diesel cylinders. Compare your records with this typical instance of the remarkable performance of Nonpareil HD in low-cost Diesel operation. Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.



Four-year cylinder-wear record on ten-cylinder Model 33-E-16 F-M Diesel

Key to Measurements in Table

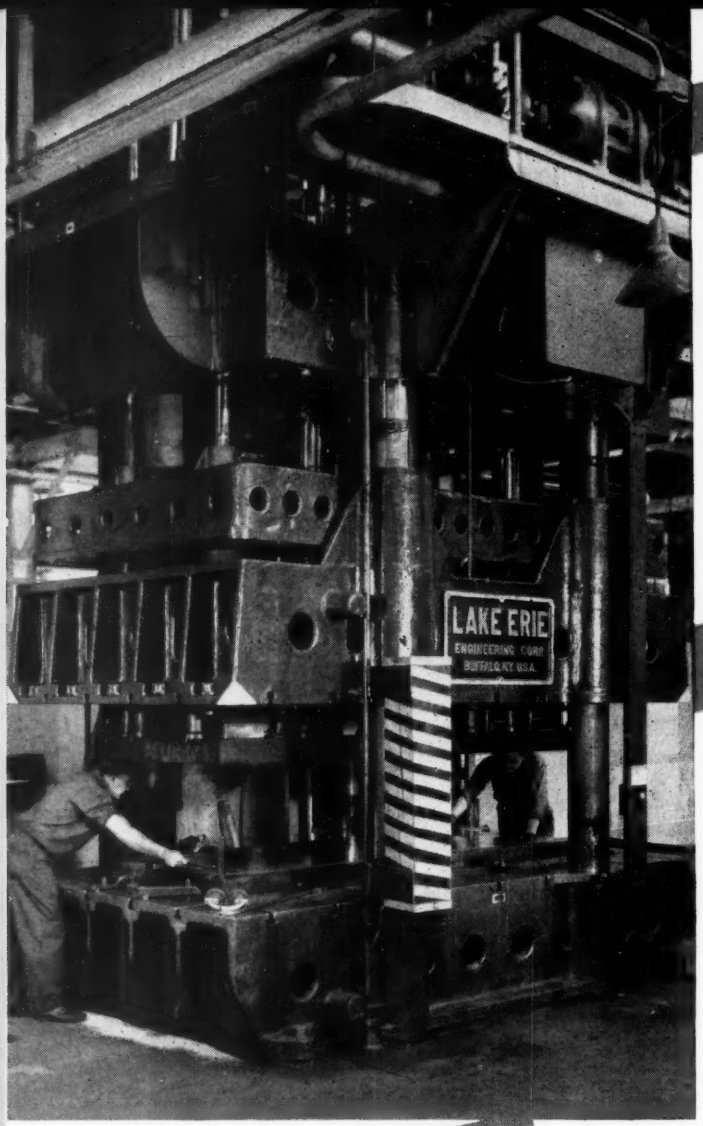
(A)—At right angle to crankshaft
(B)—Parallel to crankshaft
(1)—One inch below top ring travel
(2)—Half way between top of cylinder and top of ports
(3)—One inch above ports

Average wear on all 10 cylinders

	A	B
(1)	.012″	.011″
(2)	.010″	.006″
(3)	.014″	.011″

Engine manufacturers recommend that cylinders be rebored when wear reaches .080″.

STANDARD OIL COMPANY (INDIANA) STANDARD SERVICE



Tests prove hydraulic oil "like new" after three years' operation

January 1944, Stanoil was placed in a large hydra press, newly installed at the Flour City Ornamental Co., Minneapolis.

June 1947, a laboratory inspection was made of original fill of Stanoil, then in its fourth year of al continuous service. Below are the significant test figu

Viscosity (SUV @ 100°F.) . .	303 seconds
Oxidized oil	.01%
Color Increase (NPA)	½ unit

The viscosity figure of 303 seconds was within the oil specification range of 300-310 seconds. This fact, the extremely low per cent of oxidized oil and the sl color change, indicated that there had been practically oxidation of the oil in three years. Because of these fact the hydraulic system stayed clean and the hydraulic trols functioned smoothly on this press at all times.

Stanoils contain an oxidation inhibitor and an anti-f additive which give these oils long life and reliable op ating quality in hydraulic systems, as well as in circulat systems, speed reducers and similar equipment. A Sta ard Oil Lubrication Engineer will help you put this e nomical oil to work in your plant. Write Standard Company (Indiana), 910 South Michigan Avenue, C cago 80, Illinois.

IMPROVED STANOIL

STANDARD OIL COMPANY (INDIANA)

STANDARD SERVICE

USE THESE BETTER

Vogt Products

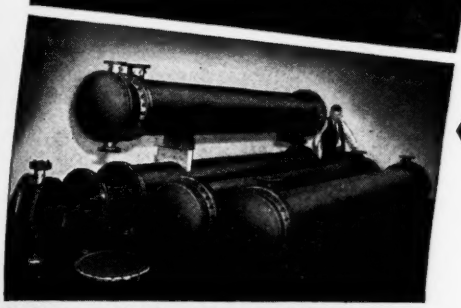
For Today's Tough Service Demands

EFFICIENT AND DEPENDABLE STEAM GENERATION

Vogt steam generating units are designed to give maximum rating in a minimum of space with high efficiency and low maintenance expense. Bent tube types and straight tube, forged steel sectional header types to burn solid, liquid or gaseous fuels, as desired, meet every power, heating or process requirement.

PROCESS EQUIPMENT FOR EVERY SERVICE

Stills, towers, oil chilling machines, filter presses, heat exchangers, etc. are constructed to all Codes. They meet all demands for operating security and trouble-free performance and help to lower costs in important process industries around the world.

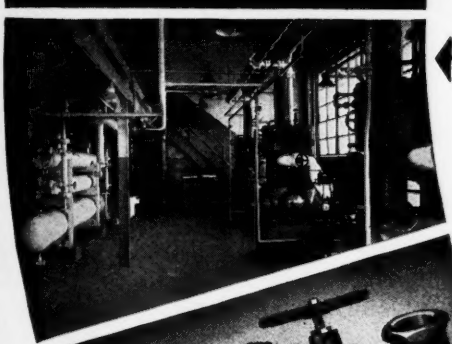


SPECIAL MATERIALS FIGHT CORROSION AND PRODUCT CONTAMINATION

Our modern shops produce a wide variety of equipment made from special metals and alloys to combat corrosion, and product contamination or discoloration. Fabrication procedures employed insure that corrosion resistant properties of welds will match that of the materials from which units are constructed.

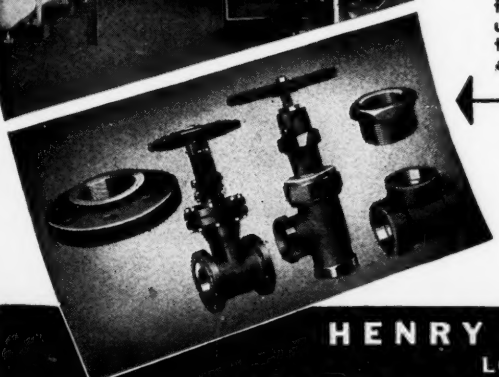
MORE TONNAGE AT LESS COST

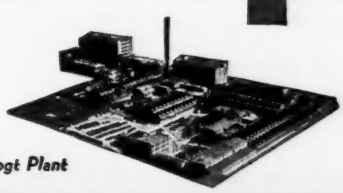
Over 60 years of manufacturing experience, engineering and research stand behind Vogt refrigerating and ice making machinery. Absorption Systems, Compression Systems, and the Automatic Tube-Ice Machine in a wide range of capacities serve in leading petroleum refineries, chemical plants, ice and cold storage plants, dairies, packing plants, etc., at home and abroad.



DROP FORGED FOR EXTRA TOUGHNESS AND LONG-TIME SERVICE

Vogt valves, fittings and flanges, for top performance in oil, water, air, gas, and ammonia services, at high or low pressures and temperatures, are available drop forged entirely from carbon steel or stainless steel. Valves can be furnished in a combination of materials by using stainless steel for parts affected by service temperature or corrosion, and less expensive alloys or carbon steel for other parts.





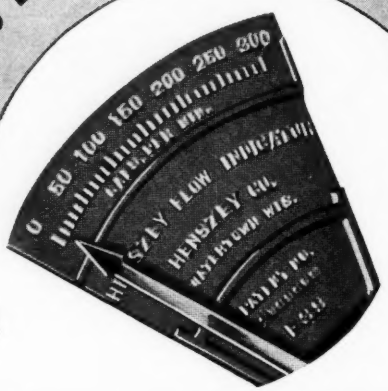
Air View of Vogt Plant

HENRY VOGT MACHINE CO.

LOUISVILLE 10, KENTUCKY

BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS

Accurately Indicates
ANY FLOW
ZERO TO 100 PER CENT



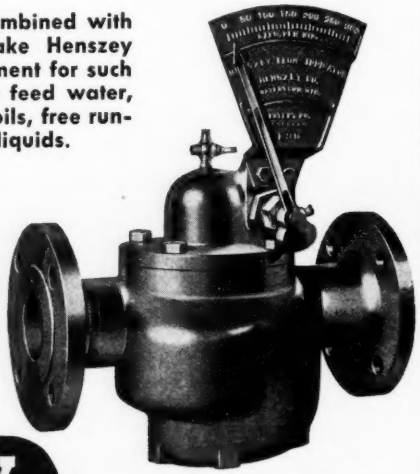
HENSZEY *Flow* INDICATOR

Henszey Flow Indicators respond immediately as soon as any free-flowing fluid passes through. They instantly and accurately register the rate of flow from zero to 100 percent and tend to indicate pulsating flow exactly as it occurs. Graduations on the dial are uniformly spaced and read direct. Only three moving parts assure accuracy and eliminate breakdowns due to complicated gears and mechanisms. Installation is simple — directly in the pipe line without additional supports.

Features such as these—combined with rugged construction — make Henszey Flow Indicators ideal equipment for such diversified liquids as boiler feed water, condensate, gasoline, light oils, free running chemicals, and other liquids.

If yours is a tough flow measuring problem, consider Henszey Flow Indicators.

Send for Bulletin FI-1



HENSZEY COMPANY
Department C11
Watertown • Wisconsin

HENSZEY
FLOW INDICATORS

Continuous Blowdown • Distillation Systems • Heat Exchangers
Feed Water Meters • Boiler Feed Regulators • Proportioning Valves
also MILK EVAPORATORS and PRE-HEATERS

Mines has combined in a single publication all of the material used successfully in the wartime National Fuel Efficiency Program that resulted in the saving of millions of tons of coal annually and in proportionate savings in other fuels, James Boyd, director of the bureau, announced recently.

Copies of Bulletin 466, "A Guide for Reducing Fuel Consumption in Commercial Plants," may be obtained only from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for 50 cents. This Bulletin is NOT sold by the Bureau of Mines.

BROADLEY GOES WITH YELLOTT ON LDC

PETER ROBERT BROADLEY, mechanical engineer of the Central Railroad of New Jersey, was granted leave by that railroad on June 23 to go with Bituminous Coal Research, Inc., to assist Dr. John I. Yellott, director of research of the Locomotive Development Committee in the development of the pulverized-coal-burning gas-turbine locomotive. During Mr. Broadley's leave of absence, his place as mechanical engineer on the Central Railroad of New Jersey will be taken by George C. Wilms, regional motive power inspector of the Baltimore & Ohio, at Cincinnati.

Mr. Broadley was born in Scotland, but attended the public and high schools in Elizabeth, N. J., and has received the degrees of B.S. and M.E. from the Newark Technical School and College of Engineering. He has also studied at Stevens Institute of Technology. He entered the service of the Central of New Jersey in 1923. After serving a special apprenticeship he has been continuously in the service of that company except for a period of about two years, when he was a draftsman and shop production engineer for International Mack Motors Co. He was appointed mechanical engineer of the C.R.R. of N.J. on September 1, 1943, and naturally, because of the interest of his railroad in bituminous coal, has been keenly interested in the program of bituminous Coal Research, Inc.

PILOT PLANT FOR COAL GASIFICATION

THE RESEARCH and Development Division of Pittsburgh Consolidation Coal Co. announced recently that contract for the design and construction of its coal gasification pilot plant has been awarded to Chemical Plants Division of Blaw-Knox Co.

This pilot plant is a cooperative project sponsored jointly by Standard Oil Development Co. and Pittsburgh Consolidation Coal Co. The purpose of the plant is to ascertain whether a practical and commercial process can be found for making synthesis gas, a first step in producing synthetic fuel from coal.

Present estimates indicate the cost of the pilot plant will be in excess of $500,000. It will be located at Library, near the coal company's research center.

The pilot plant will be a completely integrated and continuous processing unit, the heart of which will be a synthesis gas generator, a cylindrical column supported by a steel structure about 80 feet high.

The pilot plant will generate approximately 1,000,000 cu ft of synthesis gas per day.

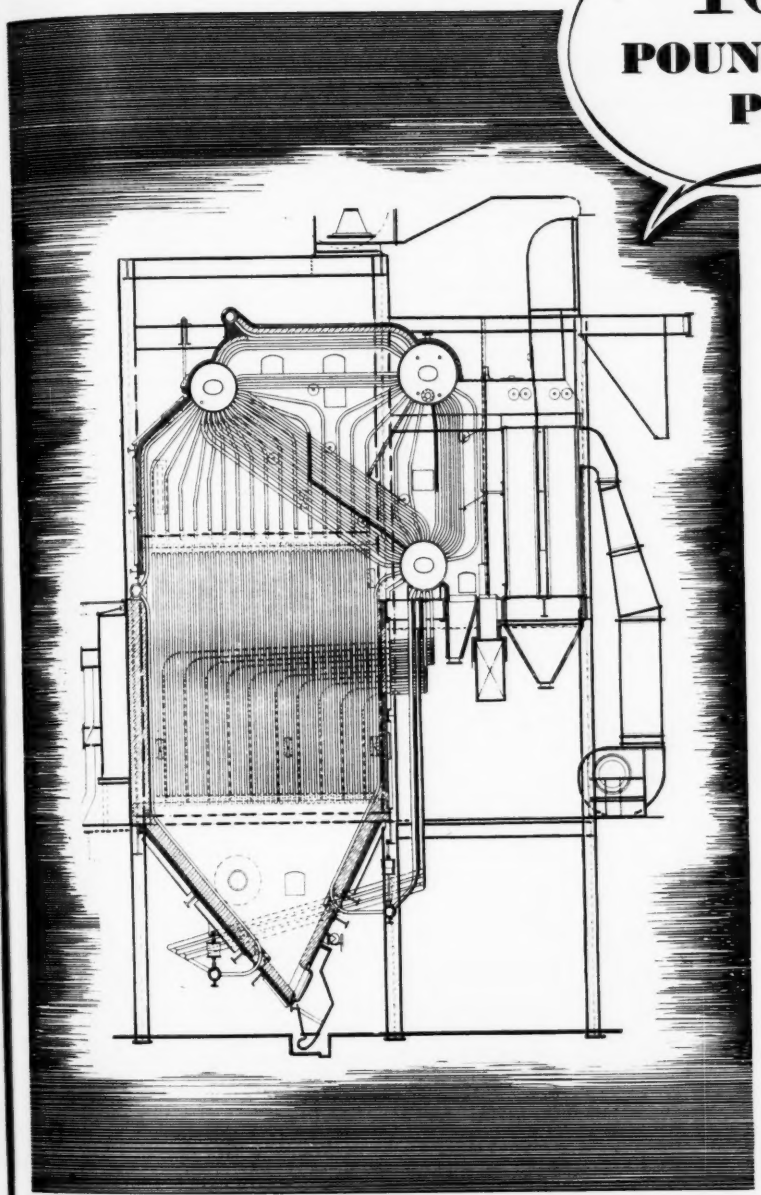
According to Blaw-Knox Co. construction work is expected to begin later this year.

FIVE-YEAR DIESEL EDUCATIONAL PROGRAM

MAKERS of Diesel engine parts and accessories joined forces September 12 with the makers of Diesel engines themselves, in a five-year educational program designed to help colleges and universities turn out a better type of engineer.

Actually, the formal meeting of parts and engine builders at the Copley Plaza Hotel in Boston was the culmination of a

100,000
POUNDS OF STEAM PER HOUR



Purchaser—
Industrial Plant, Great Lakes Area

Number of Boilers 1

Type of Boiler—
Erie City 3-drum Steam Generator

Pounds of Steam/Hr. . . . 100,000

Design Pressure . . . . . 200 PSI

Operating Pressure . . . . . 160 PSI

Air Preheater—
Erie City Tubular Type

Water Walls–
Erie City Bare Tube

Erie City 3-Drum Boilers in any size or pressure are combined with Erie City Water Walls, Air Preheaters, Economizers, Superheaters and Pulverizers to meet any steam requirement. Over 100 years devoted to building steam power plant equipment for industry is your assurance of a soundly engineered unit. May we have our nearest sales engineer consult with you?

STEAM POWER PLANT EQUIPMENT

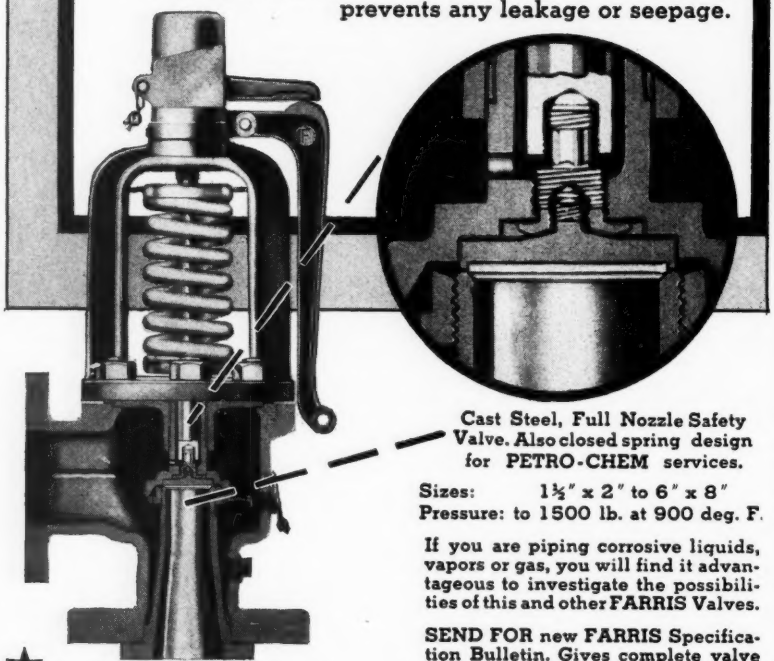
Complete Steam Generators • Type C 3-Drum Boilers • Type VL 2-Drum Boilers • The "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • Coal Pulverizers • Underfeed Stokers and Welded Pressure Vessels for the Process Industries.

ERIE CITY
SINCE 1840

ERIE CITY IRON WORKS • ERIE, PA.

CERTIFIED CAPACITY
97½% Kd.★
Certified by Actual Unbiased Test

- Certified capacity—by actual test at The National Board of Boiler and Pressure Vessel Inspectors Laboratories . . . your warranty that this valve has the specified relieving capacity . . . your assurance of complete protection for the equipment served.
- Certified construction . . . your assurance of structural soundness and design for specified pressure.
- 2½ to 1 guide ratio of the disc guide assures full lift and positive reseating.
- Combination of nozzle and inverted cone or secondary nozzle makes maximum use of the kinetic energy of the discharge to effect high lift and full capacity.
- Floating disc, operating through an *Alignment Spool* and double universal joints ensures perfect seating of the disc on its nozzle which effectively prevents any leakage or seepage.



Cast Steel, Full Nozzle Safety Valve. Also closed spring design for PETRO-CHEM services.

Sizes: 1½" x 2" to 6" x 8"
Pressure: to 1500 lb. at 900 deg. F.

If you are piping corrosive liquids, vapors or gas, you will find it advantageous to investigate the possibilities of this and other FARRIS Valves.

SEND FOR new FARRIS Specification Bulletin. Gives complete valve selection for ready use.

★*Capacity is equal to a theoretically perfect nozzle of like size blowing direct to atmosphere.*

FARRIS ENGINEERING CORP.
400 Commercial Ave.
Palisades Park, N. J.

Farris

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SAFETY and RELIEF VALVES

FARRIS keeps pace with advancing power and process engineering

plan that the Diesel Engine Manufacturers Assn. had conceived months ago, and to which it had obtained pledges of cooperation, one by one, of the engine parts builders.

The plan is a new development of three years of educational work which up to now has been shouldered by the association itself, it was explained by E. J. Schwanhausser, who heads the association and is vice president of Worthington Pump & Machinery Corp. Methodically since 1944 the association has visited the accredited mechanical engineering schools of the country, checking their needs and finding them, in many instances, to be acute. Laboratory equipment in particular was inadequate.

Diesel Engine Manufacturers Assn. has been able to improve the situation insofar as needs directly related to Diesel engines themselves were concerned. It has become increasingly apparent, however, that educational problems are inseparably tied up with such factors as governors, fuel injection systems, lubricators, pistons, piston rings, fuels, lubricants, filters, silencers, crankshafts, camshafts, instruments, bearings, superchargers and radiators. There could be but one conclusion: the parts makers' cooperation is needed to help the schools graduate a better type of engineer.

Gordon Lefebvre, president of Cooper-Bessemer Corp. and chairman of DEMA's educational committee, expanded on the help the association has given the schools. Diesel Engine Manufacturers the country over have been "hosts for the day" to visiting college instructors who in some instances have traveled hundreds of miles, and at their own expense, to tour the factories and see first-hand the latest manufacturing processes and research projects, so that they might return to their classrooms better equipped to teach their students. Manufacturers have taken the opportunity also to show their guests the educational aids that they, the manufacturers, had to offer them, such as working models, cutaway sections, films, slides and literature.

The intensive two-week "refresher course" held in 1946 at Pennsylvania State College with that school's cooperation, and the one-week session held this year at Chicago, when two schools and three factories were visited, also were described.

"As a result of our efforts," Mr. Lefebvre said, "the laboratory equipment of the schools is twice as good as it was two years ago. The caliber of the instructors also is better. But text material is inadequate and calls for serious improvement. There is a real need for the cooperation that you parts and accessory makers can give us."

A preview of some of the activities this cooperation will include, was disclosed by Harvey T. Hill, executive director of Diesel Engine Manufacturers Assn. He asserted that George H. Amberg, recently added to DEMA's staff to devoate his full time to educational work, will visit all schools "to get first-hand the complete picture of their laboratory equipment, text material, and outline of their courses. His advice and counsel will improve many situations."

"As a result of his efforts and our overall program," Mr. Hill continued, "I am sure you will find that a year from now the schools will have better equipped laboratories, better text material and, in many cases, better courses, with thesis work being done in practical fields, in a practical manner."

Parts makers' literature of a helpful type, is badly needed by the schools, Mr. Hill added, and where it is not available in certain fields the association will create it.

A parts makers panel at one of the top-ranking universities is among the association's ideas for the future. It would be attended by college professors, parts makers, and engineers drawn from the Diesel industry.

Endeavors to improve Diesel engine trade

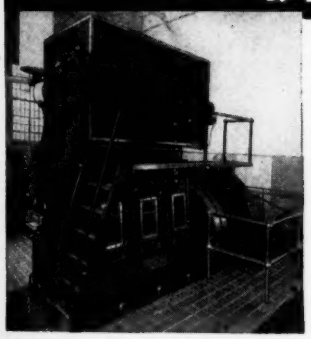
FACTORIES
OFFICE BUILDINGS
MEAT PACKERS
BREWERIES
HOSPITALS
PLA
DAIRIES
PAPER MILLS
FURNITURE
METAL WORKING PLANTS
BUILD
METAL
NTS
INGS
HOTELS
MILLS
SCHOOLS
TOBACCO
COLD STORAGE
POTTERIES

They all get the same answer . . .

It's Cheaper to Generate Our Own Electric Power

with **SKINNER**

"Universal Unaflow"
STEAM ENGINES



600 kw. Multi-Cylinder Vertical "Universal Unaflow" Steam Engine

Three 200 kw. Horizontal "Universal Unaflow" Steam Engines

The economies enjoyed by those who are using Skinner "Universal Unaflow" Steam Engines to generate their own electric power instead of purchasing it are not limited to peculiar situations or to narrow classifications. Skinner Engines are saving money every month for thousands of owners, including hospitals, schools, hotels, office buildings, packing plants, breweries, dairies, laundries, textile mills, potteries, furniture factories, metal working plants, and dozens of others.

The economies of electric power generated on the premises by Skinner Steam Engines are not limited geographically. Owners cover the map from Minnesota to Texas, from New England to California, and dot the rest of the globe.

The economies of generated power are not limited by requirements. Skinner "Universal Unaflow" Engines are built in sizes from 75 to 3000 hp. in horizontal and multi-cylinder vertical types, for direct connection, coupling, or belt drive, to electric generators, compressors, blowers, pumps, lineshafts, or other load.

In short, the economies enjoyed by generating power with Skinner Unaflow Steam Engines are limited only by the number of users.

Skinner "Universal Unaflow" Engines are frequently bought under our Guaranteed Savings Contract, payments being made out of proved savings after the engine is in service. Write for detailed information of the advantages of Skinner "Universal Unaflow" Engines in your industry.

For Over 75 Years, Doing One Thing Well—Building Steam Engines

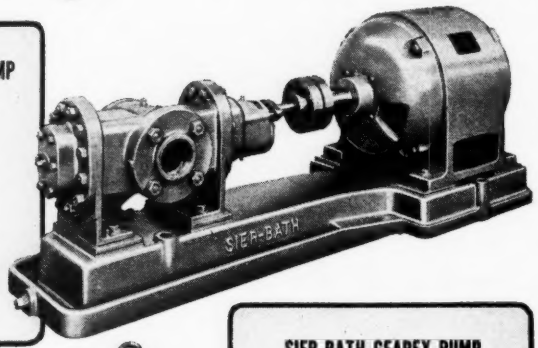
SKINNER ENGINE COMPANY, ERIE, PA.

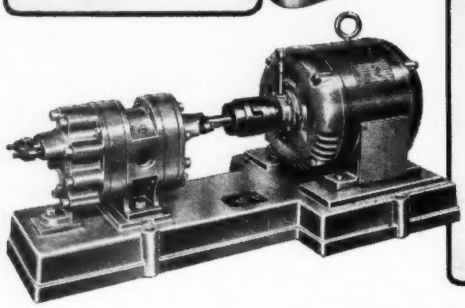
ONE PUMP working on the job is *worth a dozen* in the repair shop!

SIER-BATH SCREW PUMP

Advantages: • pulseless flow • anti-friction bearings • vibrationless operation • low maintenance cost • rugged construction.

Pumps: Acetate, asphalts, brines, Bunker C Fuel Oil, Cellulosics, Greases, Molasses, Syrups, Lube Oils, etc.





SIER-BATH GEAREX PUMP

• Balanced Axial Thrust • Pulseless Flow • Vibrationless Operation • Roller Bushings for Precision Running under load.

Pumps: Oils, Varnishes, Solvents, Molasses,, Chemical Solutions.

Capacities: 1-550 g. p. m.

Discharge: 250 p. s. i. for medium or high viscosities. 50 p. s. i. for water.

The most notable point about SIER-BATH Screw Pumps and Gearex Pumps is their relative freedom from maintenance.

THERE is no mystery about the ability of Sier-Bath Pumps to stand up under the most trying conditions. After all, in such pumps, the worms and gears are the most important parts. And when you consider that Sier-Bath Pumps are made in the best equipped precision gear shop in the country, it is easy to understand their exceptional dependability. Their pulseless flow and vibrationless operation greatly reduce maintenance cost—there is much less wear on valves, couplings and other fittings. Pipes and joints remain tight. With labor costs at their present high figures, these are important points to consider in pump selection. Send for descriptive booklet.

ALSO MAKERS OF SIER-BATH PRECISION GEARS

FOUNDED 1905 **MEMBER A. G. M. A.**

Sier-Bath GEAR and PUMP CO., Inc.

9256 HUDSON BOULEVARD • NORTH BERGEN, NEW JERSEY

schools also have a place on the educational program, Mr. Hill added.

He then threw open the meeting for comments and suggestions from the 27 representatives of parts manufacturers who were present.

Net result was the unanimous carrying of a motion that DEMA's board of directors appoint a committee to head up and carry through a cooperative educational program to be set up by the makers of Diesel engine parts and accessories, and makers of Diesel engines.

Construction has started on a new chlorine and caustic soda plant to be built for the Dominion Alkali & Chemical Co., a subsidiary of the Dominion Tar & Chemical Co., Ltd., at Beauharnois, Quebec, according to a recent announcement by The H. K. Ferguson Co.

C. F. Wiley has been promoted to be assistant manager of the Chicago district sales office of American Steel and Wire Co. Bruce D. Bennett has been named manager of the electrical, wire rope and construction materials division here, succeeding Mr. Wiley.

The appointment of Walter Ramberg as chief of the Mechanics Division of the National Bureau of Standards has been announced by Dr. Edward U. Condon, director of the Bureau. He will succeed Hugh L. Dryden, who is leaving the Bureau to become director of research for the National Advisory Committee for Aeronautics.

Printed copies of Simplified Practice Recommendation R184-47, Iron Valves, are now available, according to an announcement by the Commodity Standards Division of the National Bureau of Standards. Copies are for sale by the Superintendent of Documents, Government Printing Office, Washington 25, D. C., for 5 cents each. A discount of 25 per cent will be allowed on orders of 100 or more copies.

Burlington Instrument Co. has appointed as representatives, Balch Sales Co.; Baker Building, Minneapolis, Minn., to cover the western part of Wisconsin, and Woodman, Rayfield & Potter Co., 1570 Northside Drive N. W., Atlanta, Ga., to cover the states of Georgia and Alabama.

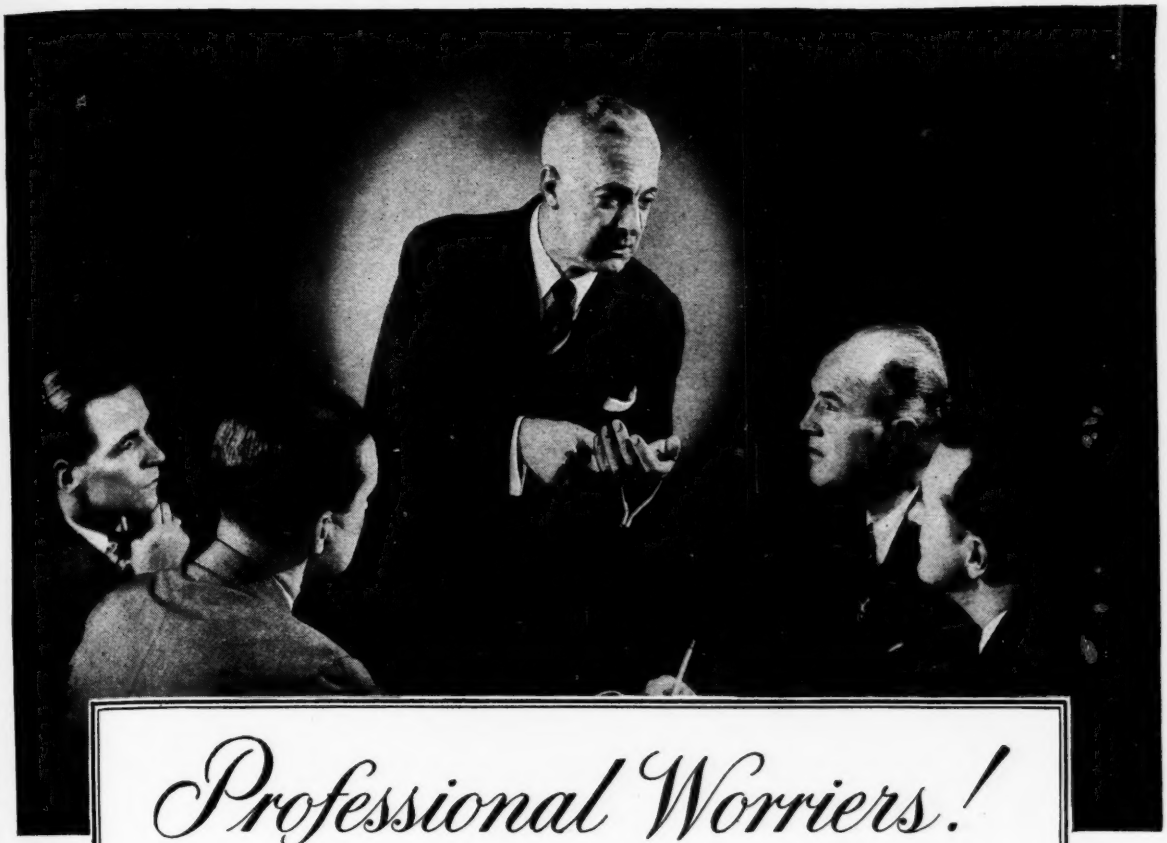
MANUFACTURERS' *Personals*

John Phillips Badenhausen, Inc., Wyncote, Pa., has announced the appointment of L. J. Westin as vice president.

David B. Hill has been appointed district field engineer in the Atlanta office of Chain Belt Co., Milwaukee, Wis. Previously he had been an application engineer in the company's Conveyor Division at Milwaukee.

Westinghouse Electric Corp. has announced the promotion of two members of the company's extensive education and training program. Henry N. Muller, Jr., former manager of graduate student training, now becomes manager of the entire educational department. His former position will be taken by Guy Kleis, who previously served as supervisor of engineering training. The promotions were announced following the resignation of Charles W. MacLean, former educational department manager.

Richard M. Barnes has been appointed Northeastern Sales and Service Manager it was announced by Dravo Corp., Pittsburgh. Mr. Barnes' headquarters will be



Professional Worriers!

Every business, time and again, runs into production snags. When the problem is *lubrication*, we're often called in to do the worrying. And eight times out of ten we come up with the right answer—*fast*. Because that's our job day in, day out, year after year—putting petroleum to work *efficiently*. This backlog of experience, coupled with the world's finest lubricants and fuels, is your best reason for calling Cities Service next time trouble calls on you.

CITIES SERVICE STOPPED TROUBLE HERE!

A screw products company in Cuyahoga Falls, Ohio, called on Cities Service for advice on machining a part of an intricate mechanism made of aluminum that required extreme accuracy and finish. Chillo Oil No. 22 was recommended. Thereafter, the manufacturer reported the machined work was not only well within the required tolerances, but the work had a mirror-like finish. Tool life was also phenomenally good.

A brick and tile company in Iowa suffered numerous failures of the main drive-shaft bearings in their Hammer Mill Crushers. Cities Service engineers recommended Pacemaker Oil No. 2. The last report from the company said that since they standardized on this lubricant, no bearing failures have occurred.

"We use Solvent No. 26 for cleaning surplus oil and grease out of electric clock movements and we find it unexcelled for this purpose" . . . so writes the president of an Illinois watch repairing and rebuilding concern after continued use of this remarkable new Cities Service metal cleaning fluid.

A bus company executive in Cleveland, Ohio, recently said, "During the past four years, we used Cities Service Heavy Duty type oil with outstanding results—minimum wear, freedom from sludge and no engine failures—which has enabled us to give uninterrupted service to our customers."

Cities Service Oil Company
Room 266, Sixty Wall Tower
New York 5, N. Y.

Gentlemen: I have a production problem that involves lubrication. I would like to discuss it with one of your lubrication engineers, without obligation, of course.

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

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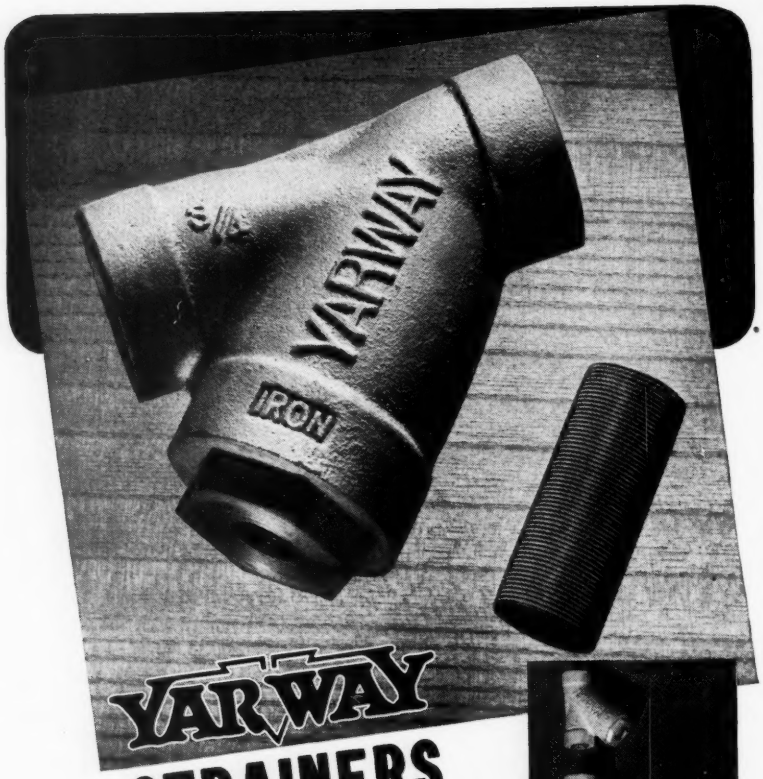
New York—Chicago

CITIES SERVICE

ARKANSAS FUEL OIL CO.
Shreveport, La.



YARWAY

STRAINERS

"Police the Pipelines"

YARWAY STRAINERS are *selling by the thousands* because they are better engineered for the service.

"*The Screen is the Thing*"—a high-grade, woven Monel wire screen that stops the dirt, lets fluids flow freely.

Then, too, purchasers like the *body finish—Cadmium plated for protection against corrosion and for better appearance.*

And last but not least, it is "*Easy to Clean*" having a steel blow-off bushing, precision machined with straight thread. Screen and bushing come out together—go back together, automatically aligning.

Six sizes, ½" to 2" for pressures up to 600 lb serve practically all strainer needs.

Sold by nearly 150 Mill Supply Houses. See your Supply House or write for Bulletin S-201.

YARNALL-WARING COMPANY
114 MERMAID AVENUE PHILADELPHIA 18, PA.

YARWAY STRAINERS

with Emerson-Swan, Inc., 712 Beacon St., Boston 15, Mass., and his territory will include New England and the northern part of New York state. He previously was assistant sales manager in the heating section of Dravo Corp.

Baxton Pollard, formerly advertising manager of A. P. Brick Co., has been transferred to Bigelow-Liptak Corp., it was announced recently by the latter concern.

Dr. R. C. Mason has been named manager of the Electro-Physics Department of the Westinghouse Research Laboratories, succeeding Gaylord W. Penney, who was recently appointed Westinghouse Professor of Electrical Engineering at the Carnegie Institute of Technology.

Ernest R. Hanson has joined the staff of Foster D. Snell, Inc., New York, to head up research and development in the field of plastics and rubber.

Harbison-Walker Refractories Co., Pittsburgh, Pa., announced recently the purchase of the Louthan Manufacturing Co., East Liverpool, Ohio.

The promotions of four Divisional Managers of Nordberg Manufacturing Co., Milwaukee, Wis., to vice-presidencies of the company was announced recently. Division managers appointed company vice-presidents are Roland W. Bayerlein, heavy machinery; H. H. Talboys, railway equipment; D. A. Cheyette, crusher; and R. R. Shafter, process machinery.

Carborundum Company, Niagara Falls, N. Y., has announced the appointment of Dr. Gurdon M. Butler, Jr., as a Senior Engineer of the Research Division. Dr. Butler was formerly Associate Director of Research of the Tool and Die Steel Division and later Chief Metallurgist at the Dunkirk, N. Y., plant of the Allegheny Ludlum Steel Corp.

Riley Stoker Corp. has announced the appointment of E. U. Titus, as eastern sales manager, to be located at their New York office.

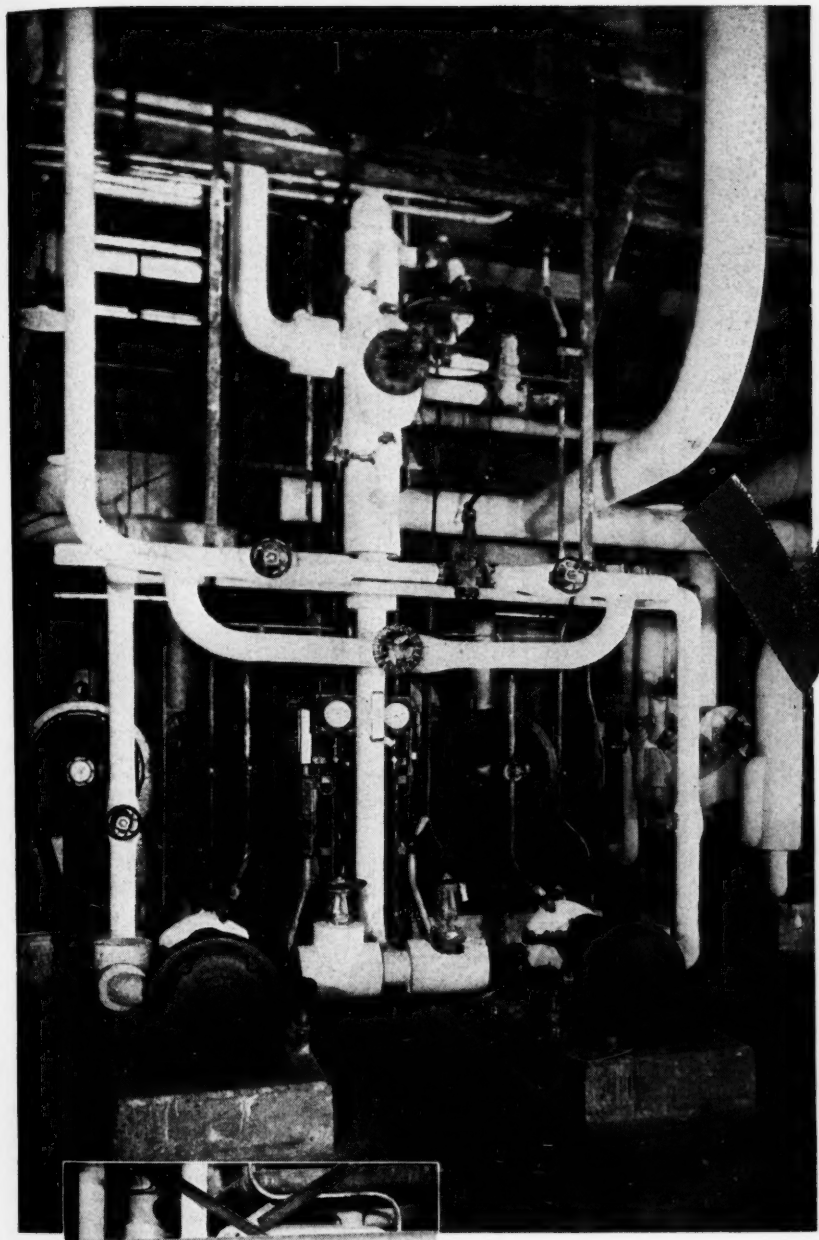
The Fred H. Schaub Engineering Co., Inc., Chicago, announces the appointment of A. W. Mortensen Co., 1004 S. E. Belmont Street, Portland 14, Oregon, as its representative in Oregon and Northern California.

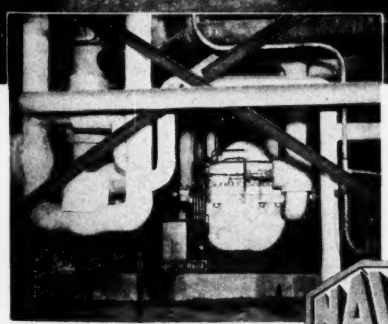
Link-Belt Co. announces the following changes in sales management personnel: Mr. James B. Elliott has been appointed divisional sales manager at the company's plant in Minneapolis, Minn. Mr. Erwin A. Wendell has been appointed divisional sales manager for Caldwell plant products, with headquarters at the Caldwell plant. Mr. T. W. Matchett has been appointed district sales manager, Chicago branch, with headquarters at the Pershing Road plant.

William E. Clark, general manager of Dravo Corp., Keystone Division, has been elected a vice-president of the corporation, at Pittsburgh.

H. W. Lingenfelter, for 23 years a lighting engineer with the Westinghouse Electric Corp., has been appointed manager of commercial, industrial and floodlighting sales for the Lighting Division in Cleveland, Ohio.

Raybestos-Manhattan, Inc., recently announced the following appointments in its Equipment Sales Division: Harry C. Dishman, equipment sales manager with headquarters in Detroit; George T. Young, branch manager of the Detroit office; E. E. Juergens, branch manager of the Cleveland office; and John E. Cole, branch manager of the Chicago office.





NAVCO PIPING INSTALLATIONS ARE THOROUGH

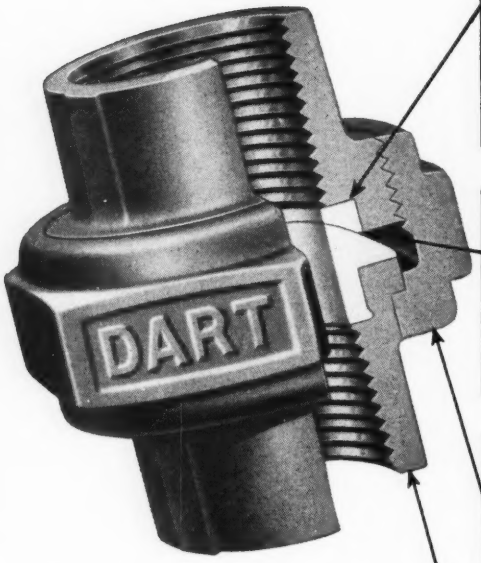
The measure of any piping system, after the proper design has been reached, is the "fit." The knowledge which we have gained in the past 40 years is your guarantee of an accurate and workmanlike piping system. Navco quality in workmanship and design is evidenced by the many successfully operating installations which we have made for every industry. Consult Navco for your next piping job.

NAVCO

NAVCO PIPING

NATIONAL VALVE & MANUFACTURING COMPANY • PITTSBURGH, PA.

NEW YORK • CHICAGO • CLEVELAND • BOSTON • ATLANTA • TULSA • BUFFALO • CINCINNATI



2 BRONZE SEATS
Precision Ground
Non-Corroding

TRUE BALL JOINT
Drop-Tight
Leak-Proof

EXTRA-HEAVY SHOULDERS
Withstand strains
and abuse

MALLEABLE IRON BODY
Practically
indestructible

These Quick Facts Show

DART SUPERIORITY

Dart unions maintain an absolutely tight seat seal. This tightness of seal is based on the two precision-ground bronze seats which form a true ball joint. Since the seats are bronze, they're non-corroding; and since they form true bearing surfaces, they're leak-proof. Darts require no packing and can be easily uncoupled for use in other locations. Body and nut are practically indestructible because they're made of high-test, air-refined malleable iron.

Ask your supplier to demonstrate Darts.

E. M. DART MFG. CO.
PROVIDENCE 5, RHODE ISLAND

DART
UNIONS

The appointment of Mr. H. L. Boetsch as vice president in charge of sales of Pennsylvania Flexible Metallic Tubing Co., Philadelphia, was announced recently.

Mr. Albert Musschoot, a member of the general engineering staff of Link-Belt Co. at Philadelphia, has been appointed assistant to the chief engineer, with headquarters at the company's general office, 307 N. Michigan Ave., Chicago, Ill.

Fairbanks, Morse & Co. has announced the appointment of L. A. Weom as manager of the company's Pump Division to take the place of Mr. Arnold Brown, who has resigned. Mr. Weom has been with Fairbanks, Morse & Co. starting in January, 1929, as an assistant in the Pump and Electric Department of the company's St. Paul, Minn., branch.

Allan J. Anderson has been appointed manager of the American Potash & Chemical Corp. plant at Trona, Calif. Anderson succeeds Walter J. Metzger, who resigned.

Fred F. Loock, formerly vice president and general manager, was elected president of the Allen-Bradley Co., Milwaukee, Wis. At the same meeting, Harry L. Bradley was named chairman of the board, in which capacity he will continue to be active in the corporate direction of the company. Other officers, who were re-elected, are R. W. Whitmore, vice president and works manager; Louis Quarles, secretary; and A. F. North, treasurer.

Arthur Koehler has been appointed production manager of Sorensen & Co., Inc., Stamford, Connecticut, it was announced recently.

Thomas B. Moule, assistant director of sales in the Los Angeles office of the Plomb Tool Co. has been assigned the responsibility of supervising Plomb's sales organization in the eastern half of the United States, it was announced recently. His headquarters temporarily will be at the company's sales office at 549 W. Washington Street, Chicago. Jack G. Allen has joined the Plomb sales staff to take over the duties previously handled by Mr. Moule and to supervise the Export Department.

Joseph F. Chalupa has been appointed manager of design engineering of the Westinghouse Aviation Gas Turbine Division, Lester, Pa.

Col. A. E. Higgins has been named vice president of the Rockwell International Corp., New York City, it was announced recently.

H. D. Worthington has been appointed supervisor, construction material sales, Chicago district, American Steel & Wire Co.

Skinner Engine Co. has announced the appointment of Stuart D. Brown, 401 Broad St., Sewickley, Pa., as district sales representative in the Pittsburgh area.

MANUFACTURERS' *News*

GAS-DIESEL OPERATION AT CHEROKEE, OKLA., PLANT

FUEL ECONOMY records for a 1440-hp supercharged gas-Diesel in a municipal power plant at Cherokee, Okla., have recently been released. This unit, which was the first of its type to be delivered, is an 8 cylinder Type LS, and has been in continuous service since March of this year. It was built by The Cooper-Bessemer Corp., Mount Vernon, N. Y. Fuel costs for the various loads, from 100 per cent

A powerful, streamlined motor drives the Lagonda cleaner, with its whirling cutter head, through the toughest scale and around difficult tube turns. It's a "scale-killer" under any scale conditions, on all tubes—straight or curved.

A special lubrication system provides a continuous flow of oil to all necessary parts of air-driven motors, including the front bearing, so that longer life and trouble-free operation are assured. Water-driven motors are water lubricated. Rugged, heat-treated crown cutters chew up every bit of scale on the first bite. And "trackless" cutter teeth are spaced unevenly so as to avoid striking the same point as they revolve inside the tube.

Get all the facts about Lagonda 1300 and 2000 series cleaners for boiler tubes now. Illustrated bulletins available on request.

ELLIOTT COMPANY
Lagonda Division, SPRINGFIELD, O.
Plants at: JEANNETTE, PA. • RIDGWAY, PA.
SPRINGFIELD, O. • NEWARK, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES

Lagonda
TUBE CLEANERS

Y-269

Embrittlement Bugaboo Baffled!

with De-ionized Water for your boiler feed

ILLCO-WAY Caustic embrittlement is eliminated when ILLCO-WAY De-ionizers are used to treat the makeup. Silica, which acts as an accelerator for embrittlement, is also removed by de-ionizing. There is never danger of sodium hydroxide nor local concentrations of strong caustic when a solids-free water is used as boiler feed.

ILLCO-WAY Proper sulphate and carbonate ratios are easily and accurately maintained at all times —assuring clean boiler operation with freedom from scale corrosion and carry-over. ILLCO-WAY De-ionizers will produce thousands of gallons of ideal feed water for only a few cents.

ILLCO-WAY Get the facts about this new process! Let our engineers, who have pioneered in water treatment for boiler feed, give you *real help* with your problem. Write for literature today.

ILLINOIS WATER TREATMENT CO.
850-11 Cedar Street, Rockford, Illinois
7310-PP11 Empire State Bldg., New York

TESTED IN THE LABORATORY * ILLCO-WAY * PROVED IN THE FIELD

Boiler Feed-Water Treatment

Complete equipment for Chemical Processing: Purification of industrial wastes, Separation of Chemical Solutions, Purification of Chemical Solutions, Reclamation of Valuable Constituents

to 25 per cent, for this new gas-Diesel are shown in the table.

This table is computed on a basis of the fuel costs prevailing at the Cherokee plant. Natural gas at that plant costs 18 cents per 1000 cu ft for the first 1,150,000 cu ft and 12 cents per 1000 for the remainder each month; Diesel fuel costs 7 cents per gallon.

Gas-Diesel—Present (d)

	Per Cent Load			
	100	75	50	25
Btu/bhp/hr, total	6400	6750	7350	8950
Btu/bhp/hr, gas	6080	6323	6710	7670
Cu ft/mo x 1/1000	6400	4980	3530	2015
Cu ft at 18c x 1/1000	1750	1750	1750	1750
Remainder x 1/1000	4650	3230	1780	265
Cost 1750 M at 18c	$315	$315	$315	$315
Cost remainder at 12c	$558	$388	$213	$32
Cost gas/mo	$873	$703	$528	$347
Btu/bhp/hr, oil	320	427	640	1280
Gal oil/mo	2355	2355	2355	2355
Cost oil/mo at 7c	$165	$165	$165	$165
Total cost, gas and oil per mo	$1038	$868	$693	$512
Total cost, gas and oil per yr	$12456	$10416	$8326	$6144

HOEHN RETIRES

CHARLES S. HOEHN has announced his retirement as President of Enterprise Engine and Foundry Co. of San Francisco. Starting as an apprentice with Enterprise 57 years ago Mr. Hoehn rose to the Presidency of the company, which position he has held for the past 30 years. While his retirement will relieve him of active duties as the head of the Company, Mr. Hoehn will continue to serve on the Board of Directors and in a special consulting capacity.

Manzel Brothers Co. has changed its name to Manzel, Inc., and completed an extensive expansion and modernization program.

Gardner-Denver Co. has announced the opening of three new branch offices, to be located in New Orleans, Cleveland and Kansas City.

Square D Co. has announced formation of a General Sales Department to coordinate sales promotion, advertising and overall sales policies of the company's electrical Divisions.

Hammel-Dahl Co., Providence, R. I., has announced the appointment of Mr. O. T. Clarke, Clarke Sales Engineering Co., Decatur, Ga., as their Dealer Representative in their Southeast territory.

Sarco Company, Inc., has announced the removal of their Head Offices, effective Sept. 1st, 1947, to Empire State Building, New York, N. Y.

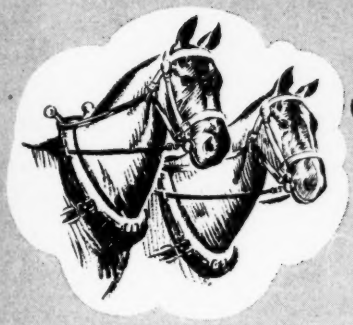
The Carborundum Co. has just received preliminary notification that its bid of $1,000,000 for a part of Plancor 168, formerly operated by Bell Aircraft Corp., has been accepted. The portion of the property thus acquired was released by the Bell Aircraft Corp. from its general option in May as being additional facilities not required by them in their programs for the future.

Metal & Thermit Corp. has announced the appointment of O. L. Howland as Sales Manager of its Welding Division with headquarters at 7300 So. Chicago Ave., Chicago, Ill.

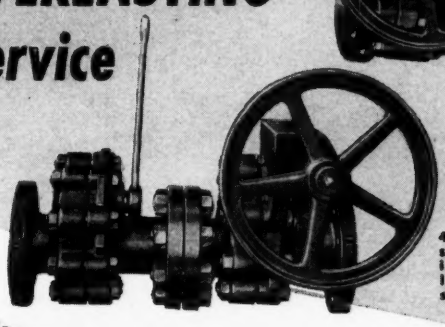
Harvey A. Mylander has been appointed District Manager for Southern California and Arizona for the De Laval Steam Turbine Co., Trenton, New Jersey. It was announced recently.

Elgin Softener Corp., Elgin, Illinois, has appointed the following representatives to handle the company's industrial line of water conditioning products: Lamb Engineering Co., 530 North Charles Street, Baltimore, Md., for the state of Maryland and Northern Virginia; Midland Laundry Equipment Co., 2800 Lyndale Avenue, So.,

EVERLASTING
Boiler Blow-off Valves...
teamed up for "EVERLASTING" service



4061/4061 Unit; angle blowing valve with wheel-operated sealing valve.



4001/4061 Unit; straightway blowing valve with lever-operated sealing valve.

The unique service qualities of EVERLASTING Blow-off Valves have long been demonstrated in boiler-rooms throughout the country. Now their superior design features have been teamed up in these new EVERLASTING Duplex Blow-off Units. And either unit far exceeds your demands for reliable service in blowing down your boilers.

HERE'S WHAT YOU GET WITH THESE NEW DUPLEX UNITS

Sealing Valve of Either Team Provides (shown on left of units)

- Lever- or wheel-operated types — as you desire
- Unrestricted flow — straight-through
- Rotating sliding disc — self-grinding, self-lapping
- Drop-tight seal — improving with use
- Non-wedge action — no sticking, no jamming

Blowing Valve of Either Team Provides (shown on right of units)

- Straight-way or angle types to select from
- Strength to withstand repeated shock of blow-off force
- Exceptional resistance to erosion, abrasion and rust
- No pockets to permit lodgment of solids
- Positive action, self-cleaning

Not only do these EVERLASTING Duplex Blow-off Units provide an absolutely drop-tight seal — they are so constructed that long and repeated operation will not affect this tightness. Other Duplex Units for varied requirements are shown in our Bulletin.

Either valve of any EVERLASTING Duplex Unit can be supplied separately. But for boiler blow-off applications, any one of the complete units assures *absolute safety — at low maintenance cost.*

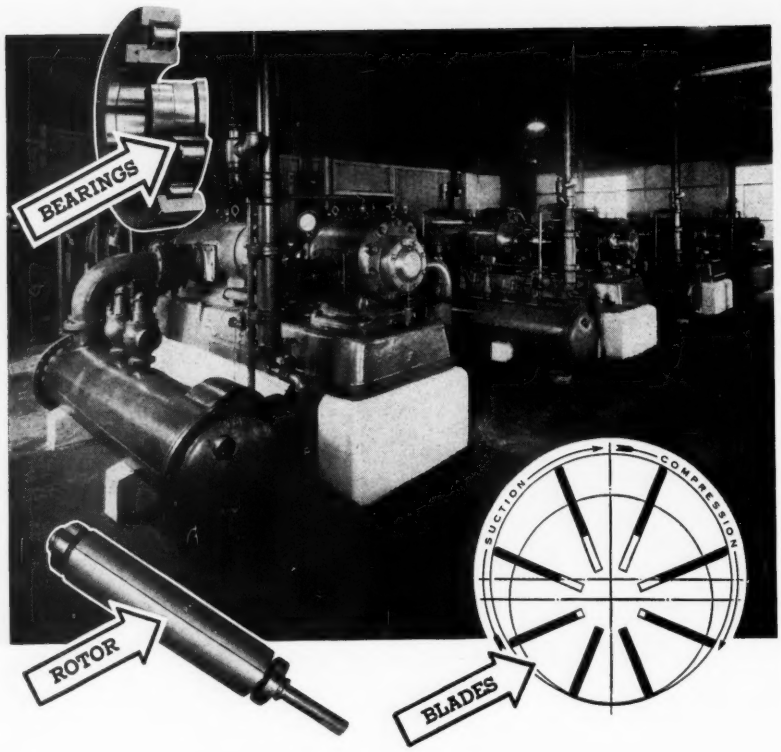
Ask your distributor — or write directly to us — for complete information.

EVERLASTING VALVE COMPANY
49 Fisk Street, Jersey City 5, N. J.

Trade-Mark "EVERLASTING"—REG. U. S. PAT. OFF.

EV-328

EVERLASTING VALVES *GIVE "EVERLASTING" SERVICE!*



Fewer Working Parts to Wear . . . None to Adjust

The fewer working or moving parts that make up any piece of equipment, the more continuous the service at lowest operating cost.

Fuller Rotary Compressors and Vacuum Pumps are an outstanding example of simplicity of design and construction . . . the only moving parts: rotor—bearings—blades.

Simple design, rugged construction for long, continuous service, that's what you get when you purchase a Fuller Rotary. There are no periodical adjustments or take-up and, due to design and construction, *original capacities are maintained for the life of the machine.* This simplicity of design also allows inspection and repairs to be made with minimum loss of time and at minimum expense.

Fuller Rotaries are the ideal units to install for capacities up to 3300 c. f. m., 125-lb pressure. We invite your investigation and inquiries. We'll be glad to send you Bulletin C-5, which fully describes and illustrates these machines. Send for your copy today.

FULLER COMPANY, CATASAUQUA, PA.

Chicago 3 - 120 So. LaSalle St.

San Francisco 4 - 421 Chancery Bldg.

C-152

FULLER

A LIFETIME OF NEW MACHINE EFFICIENCY

Minneapolis, Minn., for the states of Minnesota, North Dakota, South Dakota and Northwestern Wisconsin; and James N. Doyle, 2071 Glencoe Street, Denver, Colorado, for the state of Colorado.

The Carborundum Co., Niagara Falls, N. Y., announces the completion of negotiations for the acquisition of land as a site for an extensive furnace plant at Vancouver, Wash. Word was received recently of the acceptance of The Carborundum Co.'s bid for 93 acres of industrial property in the outlying district of Vancouver. The property has an extensive frontage on the Columbia River, providing ample water shipping facilities and is also served by three railroads.

B & M Mfg. Co., with general offices at 19 North Harrison St., East Orange, N. J., has recently been formed by Wiley W. McMinn, and Olof Brant, formerly Vice-President and Chief Development Engineer respectively of Agaloy Tubing Co.

Lyman C. Gross has announced the opening of engineering offices at 432 Sexton Building, Minneapolis, Minn.

The American District Steam Co., New York, announces the appointment of Equipment, Inc., 35 Westminster Street, Providence, Rhode Island, as district representatives for the State of Rhode Island and Southeastern Massachusetts.

ESTIMATED MARKET FOR SALES OF AIR-CONDITIONING SYSTEMS

FORECASTS concerning the air-conditioning of Commercial and Industrial Buildings have been brought together and placed on a common basis in a series of nine studies as shown by the accompanying summary table. This project was the work of J. F. Brinley, Account Executive of Michel-Cather, Inc.

Taken together, these nine market studies show that expenditures for the air-conditioning (of the types specified below) of Commercial and Industrial Buildings may be expected to total approximately $100,000,000 in 1947 . . . and to continue at that level for an indefinite period—dependent more upon economic factors than anything else.

It is significant that the annual total thus derived agrees closely with the total expenditures for air-conditioning in the 2 year period of 1940 and 1941, which is rather widely accepted now as a rough measure of present annual air-conditioning activity.

Private residential structures were not included in this survey. For the purpose of eliminating, so far as possible, the self-contained or "package" units of air-conditioning, the report was confined to those installations employing a "central" cooling plant with ducts running to the air-conditioned areas.

In order of importance—as measured by annual dollar-volume of air-conditioning planned for 1947—the individual fields studied were found to rank as follows: 1. Theatres, 2. Department Stores, 3. Industrial Buildings, 4. Restaurants, 5. Hotels, 6. Schools, 7. Hospitals and 8. Banks.

The ninth study, which covered "other commercial" buildings (such as retail stores, etc.), showed a larger

CONTROL...Yes

But HOW EFFICIENT?

Fig. 19084 W. E.—Class 900-pound Cast Steel Non-return Globe Valve with welding ends and Powell PRESSURE SEAL BONNET. Has compound spur gearing to provide easy operation. Stellite faced.

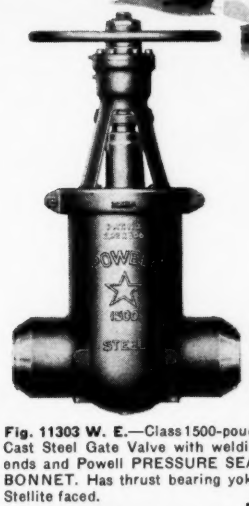


Fig. 11303 W. E.—Class 1500-pound Cast Steel Gate Valve with welding ends and Powell PRESSURE SEAL BONNET. Has thrust bearing yoke. Stellite faced.

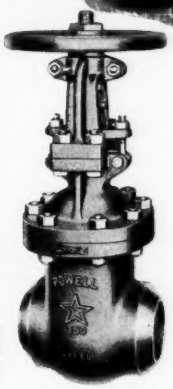


Fig. 1503—Class 150-pound Cast Steel O. S. & Y. Gate Valve with welding ends.

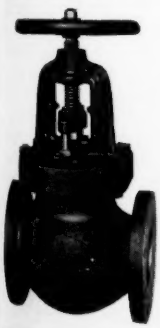


Fig. 241—125-pound Iron Body Bronze Mounted O. S. & Y. Globe Valve with regrindable, renewable bronze seat and disc.

Fig. 1793—125-pound Iron Body Bronze Mounted O. S. & Y. Gate Valve. Sizes 2" to 30" incl.

It's a long step from the Old Mill wheel to the modern power plant. Much of the difference lies in the degree of efficiency in flow control.

More than a century ago, when Powell started to make valves, industrial flow control requirements were simple. Since then the immense growth and diversification of American Industry has multiplied the demands for diversification of flow control equipment a thousandfold.

Through these many years Powell has been meeting each and every demand as it has arisen. That's why today the Powell Line is unique in that it includes valves of the right type, size, design and material to satisfy *every* known requirement of modern industry.

The Wm. Powell Company

Cincinnati 22, Ohio

DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

POWELL PRESSURE SEAL BONNET Valves are furnished with plain or thrust bearing yokes, or can be equipped for gear, toggle, or motor operation, depending upon size and operating conditions.

Fig. 19031 W. E.—Class 900 pound Cast Steel Globe Valve with welding ends and Powell PRESSURE SEAL BONNET. The internal pressure seals body-bonnet joint. Spur gear operated. Stellite faced.

POWELL VALVES

total than any of the eight individual fields listed above. A large potential market undoubtedly exists among these "other commercial" buildings, but it cannot be broken down, classified and sold in the same manner as the other eight fields.

The summary table, reproduced here, brings out a number of pertinent facts besides the total amount of money to be spent for air-conditioning in each field. It shows the total number of installations in the field, the number which now have air-conditioning installations (either partial or complete) and their percentage of the total. These percentages range from a low of 4 per cent for banks to a high of 26 per cent for department stores.

Another interesting fact brought out in the summary table is the average horsepower per installation in each field. This gives a general idea of the size and kind of installation which is typical in that field. While it is impossible to draw a hard and fast line and say that all installations below a certain horsepower are "package" units, and all above that level are "duct" installations, Mr. Brinley's studies indicated that an approximate division of this kind could be made at the level of 5 hp.

Among the "other commercial" buildings, the average horsepower per installation reported was 13½, which was the lowest average horsepower reported in any field. This suggests that not many of the installations included in the report in that classification were of the so-called "package" units, which, of course, was intentional. The same appears to be true in the hospital and restaurant fields with installations averaging 14½ hp. In the other fields covered in the survey, it would appear that virtually all of the installations included in this report are of the type using a central cooling plant with ducts running to the air-conditioned areas.

So far as the market for air-conditioning equipment in industrial buildings is concerned, it is believed that the 157,000 small manufacturing concerns in the country employing ten or less workers may be disregarded, leaving 27,000 establishments as users or prospective users of "central" air-conditioning systems.

The survey states that according to the figures of the Edison Electric Institute, there are at present only 4759 industrial plants in the United States having air-conditioning installations. The aggregate horsepower is 137,329. These installations were made as follows:

Period	Number of Plants	Horsepower
Up to 1940	2443	94,906
During 1940	970	13,590
During 1941	1346	28,833
Totals	4759	137,329

This works out to an average of 29 hp per installation, which is comparatively small and suggests only partial plant use of air-conditioning in many installations.

From surveys made, it is estimated that of the total of 27,000 major plants, about 4,000 are still very good prospects for air-conditioning. On the basis of the past record, the cost of these would probably be about $10,000 per installation (29 hp at approximately $350 per hp). For 4000 plants the total expenditure for air-conditioning in manufacturing industries would then be $40,000,000. If spread over a 5-yr period this would mean $8,000,000 per year.

In most of the fields covered, it was possible to determine rather definitely—from general modernization surveys conducted within the fields—the plans that are being made to install air-conditioning.

Estimates, based on what had actually been done in 1940 and 1941, were compared with the figures given in many separate surveys conducted within the various individual industries, and with information obtained from other reliable sources. After careful examination of all the data,

ENCO designed pump sets eliminate fuel-oil preparation troubles in the planning stage.

Today when overall plant efficiency is so vital, it is more necessary than ever for you to be sure that your fuel oil pumping and heating system is designed to provide peak performance to meet your special plant conditions.

Many years of experience in planning these installations enables ENCO engineers to design the unit that suits your operating conditions best . . . "tailor made" so that every part is integrated to provide you with easier control and longer maintenance-free operation.

ENCO pumping and heating sets are both simple and economical to install, too. They are delivered in a co-ordinated unit, ready to connect to station piping and run. And every ENCO Fuel Oil Pumping and Heating Unit is completely tested under high pressure before it is shipped to you.

ENCO "tailor made" pump sets are available in full or semi-automatic models with single or duplicate combinations of steam piston, turbine or electric driven rotary, or screw-type pumps. Pumps may be interconnected with one or two straight-tube heaters. Pumping sets with all-welded pipe connections are also available on request.

For further information on ENCO Automatic Fuel Oil Pumping and Heating Sets, write for Bulletin O.B.—37.

10 PLUS FEATURES THAT HIGHLIGHT ENCO'S SUPERIORITY

1. **COMPLETELY AUTOMATIC OPERATION** is assured by automatic temperature and pressure regulation valves.
2. **COORDINATED DESIGN SAVES SPACE.** All equipment essential to the preparation of fuel oil for combustion is contained in one compact unit.
3. **INDIVIDUALLY DESIGNED** to meet the specific needs of the particular power plant in accordance with its exact operating requirements.
4. **ALL PARTS VISIBLE AND ACCESSIBLE** for easy operation, maintenance and repair.
5. **PUMPS AND HEATERS** are interconnected to provide maximum flexibility of operation.
6. **SAFETY VALVES** protect individual parts where required.
7. **EASIER MAINTENANCE — LESS SERVICE-TIME FOR CLEANING** because straight tube, multi-pass heaters with removable heads are used.
8. **PUMPS OPERATE AT MODERATE SPEED.** Heaters designed to give the correct viscosity and velocity without fouling.
9. **SMOOTHER FLOW OF CLEAN FUEL TO FURNACE.** Air chamber for each piston pump prevents pulsations—pressure regulator for rotary pumps. Twin type strainers provided to keep atomizer tips from clogging.
10. **CLEANER BOILER ROOM . . .** all overflows connected to a common outlet; flanged drip pan catches oil drip.

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Specially Designed for Flexible V-Belt Drives

BY CHANGING ONE sheave, you can quickly change speed and capacity of this pump—adapt it to your exact needs. Further variations are possible through interchangeable impellers and casings.

That's why only three basic sizes of "Pedrifugal" pumps meet every average pumping requirement from 10 to 500 gpm, and heads up to 100 ft!

Now you can buy a pump for any normal job, right off the shelf! The "Pedrifugal" pump is versatile, compact, dependable—engineered, built and backed by Allis-Chalmers—offered at the lowest possible price consistent with high standards of design, material and workmanship.

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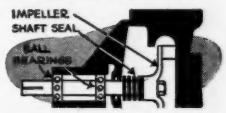
BUY IT "OFF THE SHELF" Pump can be bought "bare" or as a complete unit: pump, motor, Texrope drive and welded steel base. Also can be coupled or belted to a motor, a gasoline engine or power take-off which you already have.

LONG SERVICE WITH MINIMUM MAINTENANCE—All moving parts quickly accessible without disconnecting pipes. No packing rings to replace . . . bearings have 3 to 5 year supply of grease under normal operating conditions.

INTERCHANGEABLE CASING AND IMPELLER—1" by 1", 2" by 2" and 3" by 3" sizes differ only in impeller and casing. Pedestal casting, shaft, ball bearings, mechanical seal and impeller nut are the same in all sizes.



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1847 1947 A CENTURY OF SERVICE to Industry THAT MADE America Great

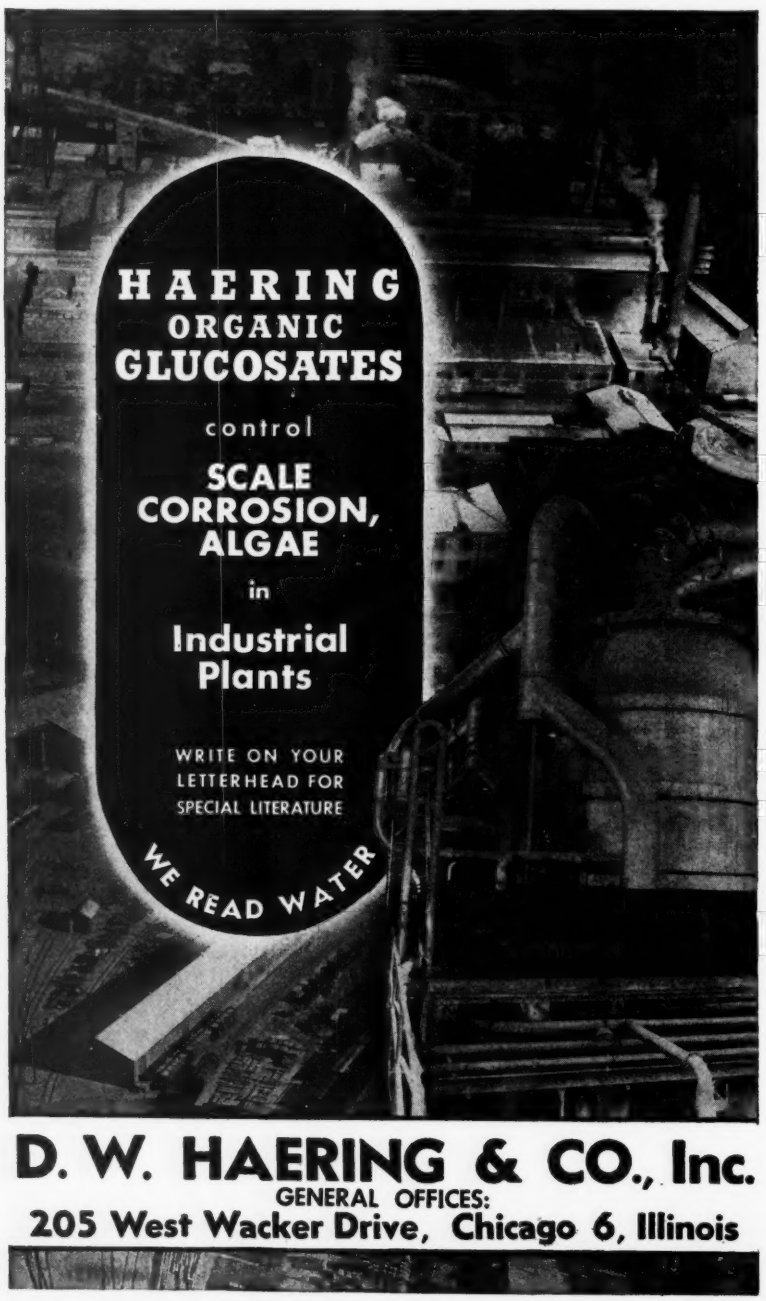
estimates were made of probable annual expenditures for air-conditioning. These estimates are presented in the column next to the extreme right in the summary table. They total approximately $100,000,000 annually, as previously stated. It should be noted, however, that all cost figures were projected upon the basis of 1940-1941 costs and do not reflect current inflationary costs.

Executives interested in this report may secure a condensed copy by writing to J. F. Brinley, c/o Michel-Cather, Inc., Two Park Avenue, New York 16, N. Y.

Air conditioning market survey commercial and industrial buildings

Type of Business or Building	Number of Units (Establishments)	No. Units Air-Conditioned (Note a)	Per Cent Air-Conditioned (Through 1941)	Total Installed Horsepower (Through 1941)	Horsepower per Installation (Through 1941)	Estimated Horsepower to be Installed V-1 (Note b)	Estimated Air-Conditioning Expenditure V-1 Based on Horsepower (Note c)	Estimated Air-Conditioning Expenditure V-1 Based on Survey Within the Industry	Michel-Cather Estimate of V-1 Air-Conditioning Expenditure
Hotels	8,713	1,214	14	50,814	42	7,221	$ 7,220,000	$ 8,000,000	$ 8,000,000
Restaurants	90,000	6,583	16	96,324	14½	14,560	8,600,000	8,000,000	8,000,000
Theatres	17,919	2,238	12½	179,320	79	18,431	6,600,000	12,000,000	12,000,000
Banks	18,902	743	4	29,017	39	5,351	1,900,000	2,800,000	2,800,000
Hospitals	6,665	327	5	7,134	22	21,430	500,000	7,600,000	7,000,000
Schools	6,356	Not available	Not available	Not available	Not available	22,050(d)	7,720,000	10,800,000	7,720,000
Department Stores	4,074	1,046	26	105,764	101	23,066	8,100,000	13,600,000	11,000,000
Other Commercial	Not available	35,299	Not available	479,006	13½	133,049	46,500,000	26,500,000 (e)	36,500,000
Total Commercial Buildings	Not available	47,630	Not available	939,781	20	235,558	$87,140,000	$89,300,000	$91,020,000
Total Industrial Buildings	27,000	4,759	17½	137,329	29	42,423	14,800,000	8,300,000	10,000,000
Total Commercial and Industrial Buildings	Not available	52,409	Not available	1,077,110	20½	277,981	$101,940,000	$97,300,000	$101,020,000

Note a - Units having air-conditioning installations, whether partial or complete
" b - Estimate for V-1 is 1940 plus 1941
" c - Based on best experience available cost is assumed at $350 per HP except in case of hotels which is $1,000 per HP
" d - Based on 2100 projects of which 30 per cent will have air-conditioning installations averaging 35 HP apiece
" e - Based on 2100 projects to cost $875,000,000 of which an estimated 3 per cent would [illegible] for air-conditioning.



HELPFUL BULLETINS

(Continued from page 46)

the catalog. Besides this material the back portion of the catalog gives a few facts about safety tools and presents a description of the approval given the tools by the Factory Mutual Laboratories. Ampco Metal, Inc.

45 **Car Shakeout**—Bulletin 128-A is described by the manufacturer as offering substantiating evidence that only two men, without manual labor, can unload a hopper bottom car in only a few minutes. This evidence is given in the form of reports from owners of the equipment. A series of photographs showing various types of rigs, some of them quite elaborate, indicates that this shakeout can be handled by any hoist that is able to lift a 5-ton load. Use of a shake-out when handling frozen material also is covered. Robins Conveyors.

46 **Torque Indicators**—Bulletin 46-T, 4 pages, describes this company's post-war line of torque indicators with capacities from 50 to 1000 ft lb. This equipment is designed to provide uniform and proper tension and the fields of application are stated to be unlimited. The outstanding features of the indicators are listed and the various types are illustrated. A table of specifications and prices is presented. Blackhawk Mfg. Co.

47 **Separators**—Catalog No. 660, 34 pages, discusses positive separation with high intensity magnetic drums and drum type separators. The catalog begins with line drawings showing the principle of operation of the drum type separator, and goes on to list what a magnetic drum will do and where they are used. Design features and how to select magnetic drums are given, with a complete ready reference table giving selection factors in percentage of rated cubic feet capacity for different classes of service. Tables, line drawings and photographs cover different types of separators, magnets, magnetic equipment and clutches. Dings Magnetic Separator Co.

48 **Air Heater**—This new 16-page bulletin describes a tubular air heater. The bulletin discusses the economic and engineering factors involved in the selection of air heaters and illustrates the types available. Numerous illustrations show their application to actual installations. Interesting and valuable charts and tables are included. The Babcock & Wilcox Co.

49 **Specific Gravity Testers**—This new bulletin includes dimensional and operational details of an improved continuous liquid specific gravity indicator. The bulletin shows how the instrument is designed for continuous indication of fluid specific gravity in closed piping systems. Line drawings and photographs of the unit are presented. Fischer & Porter Co.

50 **Silicone Data**—New data has just been released concerning a series of silicone oils numbered DC 710, DC 710G and DC 710R. This latest edition of "Silicone Notes" describes the properties of these silicone oils and their use as high temperature lubricants for conveyors and bearings exposed to severe temperatures and high humidity. The notes point out how the low volatility, chemical inertness and freedom from fuming combined with good lubrication properties make DC 710R an excellent permanent lubricant for instruments. Summaries of results of tests with chains are shown in tabular form and tables of comparative volatility and comparative lubricity of SAE 20 oil and DC 710R silicone oil, and typical properties of DC 710 silicone oil are presented. Dow Corning Corp.

In Power Plant Flues

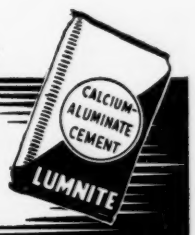
ECONOMICAL LUMNITE LININGS RETARD CORROSION AND ABRASION

Flues between boilers and stacks at a large eastern power plant had been subjected to the corrosive attack of acid condensate. Scouring action of the cinder-bearing gas had worn away the corroded metal. In sections where condensation was heaviest—outside the building—the flues had become almost paper thin. The problem was to repair these flues and to protect them from corrosion and abrasion. And the method had to be quick and economical.

The damaged flues at this station were repaired by installing a 1½-inch-thick lining of corrosion-resistant concrete made with LUMNITE cement. The lining was reinforced with wire fabric attached to lugs welded to the shell. Patch plates were welded on the outside surface over holes and thin spots. The concrete, placed with a cement gun, was tightly bonded to the steel shell.

This repair procedure saved the labor and expense of rebuilding the flues. The protective LUMNITE lining has prevented further deterioration. The insulating effect of the lining is an added advantage, as paint lasts longer on the cooler outside surface. Also, the lining stiffens the flues and eliminates vibration.

The advantages LUMNITE gave this flue repair job are applicable to many other power plant installations. For further information about this installation, and other power plant uses of LUMNITE, write to:



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CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions dictated by space requirement or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

BOILERS

51 **Steam Generators**—Catalog almost completely devoted to cross-sectional drawings with accompanying listing of principal data of typical installations in rubber companies, steel works, sugar refineries, municipal plants, etc. Details of furnace water wall construction on inside back cover; 16 pages. Henry Vogt Machine Co., Inc.

52 **Double-Pass Boilers**—Bulletin R-M-1 (6th edition); illustrates and describes this line of riveted or welded double-pass steel firebox boilers. Three full pages of dimensions, ratings and other details including dimensioned line diagrams; 8 pages. The Brownell Co.

53 **Boilers, Burners, Accessories**—Bulletin GC-10; condensed catalog of regular products for stationary power plants. Each class of equipment summarized and illustrated with line drawings and photographs. Illustrations accompanied by brief descriptions; 12 pages. Combustion Engineering Co., Inc.

54 **Standardized Boilers**—Bulletin 746; 4 page bulletin presenting construction and operation information and ordering specifications for this company's Type M boilers. Bulletin illustrated, presents table of measurement and data. Springfield Boiler Co.

55 **Steam Generators**—Presents reasons for high efficiency; shows brief case histories of plants. Results of tests by independent authorities and "Facts You Should Know About Steam Generating Unit." Ratings, dimensions and other data presented. Springfield Boiler Co.

56 **Steam Generator**—Bulletin 119; company's Type S steam generator described and features of construction are pointed out. Folder well illustrated and dimensioned drawing and table of dimensions and sizes are given. Union Iron Works.

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In installations where bedlam is taboo, Wilson Electrically Driven Equipment gives you tube cleaning on the Q.T. . . . quiet, efficient, trouble free.

And where air, steam or water are not available for tube cleaner operation, Wilson Electric Equipment will do a fast job—no matter what the deposit—even on plugged tubes.

Wilson Electrically Driven Tube Cleaners are easy to handle and operate. They are portable . . . can be taken into steam drums or slung in convenient locations. And they're built for tough service, too. The shafting, for example, is specially wound to resist torque—it won't unravel—there is no distortion.

Ideally suited for cleaning HRT and other boilers, heat exchangers, etc., Wilson Electrically Driven Tube Cleaners are available with one- or two-speed drives, for various tube sizes from ⅝" up—straight or curved. All standard Wilson accessories can be used with these Cleaners.

TW-738

Type C Electrically Driven Cleaner.

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WILSON TUBE CLEANERS

See your local Wilson representative for additional information, or write direct and mention current characteristics required.

PRIME MOVERS

57 **Axial Flow Impulse Turbine**—Bulletin S-107; six types described; data for estimates; applications; types, casings; wheels and blades; shafts, nozzles and bearings; overspeed stop and other governor features; lubrication; 8 pages. The Terry Steam Turbine Co.

58 **Multi-Stage Turbine**—Bulletin SR-114; Casing, lagging, wheels and blades; shafts, nozzles, bearings; governors; speed changer or synchronizer; governor valve and steam strainer; lubrication; general; 10 pages. The Terry Steam Turbine Co.

59 **Turbines, Pumps, Products**—This 24-page catalog covers the company's complete line of products from steam turbines to flexible couplings. Every product is discussed from the design and operation angles and the discussion is heightened in interest by the inclusion of many excellent photographs. Other products discussed are helical gears, centrifugal pumps, multi-stage pumps, screw pumps, blowers, compressors and speed reducers. De Laval Steam Turbine Co.

60 **Turbine Cleaning Manual**—This 20-page bulletin covers the step-by-step solvent and manual cleaning of turbines from the inspection and preliminary cleaning to draining and final inspection. The cleaning of bearings and governor, installation of filter unit, circulation of cleaning solvent, and displacement of cleaning oil with new lubricating oil are steps which are covered briefly but clearly. Shell Oil Company, Inc.

61 **Steam Engines**—Bulletin No. 306; Engineering data; tabular material, descriptions; 8 pages. Troy Engine & Machine Co.

62 **Generating Sets**—Bulletin No. 108; General description, typical installations, engineering data tables, details of construction, completely illustrated; 24 pages. Troy Engine & Machine Co.

63 **Stationary Diesel Engines**—Dependability, adaptability of Diesel power described and applications pointed out. Its economical and simple design is stressed. Advantages of company's equipment brought out; exceptionally well illustrated; 24 pages. Enterprise Engine and Foundry Co.

ELECTRICAL

64 **Oil Circuit Breaker**—Bulletin 71B-6421 describes Unitop oil circuit breaker; ratings from 15 to 46 kv, 500,000 to 1,500,000 kva interrupting capacity. Well illustrated. Allis-Chalmers Mfg Co.

65 **Generating, Substation Equipment**—Bulletin 25B6150 titled "More Power to U.S.A." 32 pages; sketches coverage of the company's equipment from hydro and steam turbines to switchgear and circuit breakers. Unusually well illustrated. Allis-Chalmers Mfg. Co.

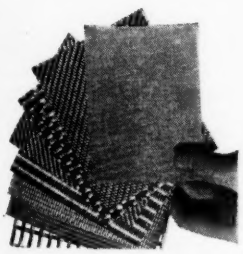
AUXILIARIES, ACCESSORIES

66 **Strainers and Separators**—Bulletin 46-50; describes complete line of company's strainers and separators. Dimensioned drawings and photographs; tables of sizes and complete description of applications, operation and design; 16 pages. American District Steam Co.

67 **Atomizing Deaerators**—Bulletin 4160; 3 color drawing illustrates description of principle of operation. Advantages of deaerators are described and illustrated; marine deaerators also covered; 20 pages. Cochrane Corp.

68 **Condensate Return System**—Description of operation and possible savings accompanied by line diagram and description of how "Jet-Loop" works; typical installation pictured and described. Drawings and text show proven results from

Look at this answer to Screen and Filter Cloth problems



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"Task Metals" for Industry

experience of users. 2 page spread of drawings and table of dimensions; 16 pages. Cochrane Corp.

69 **Low Pressure Evaporators**—Description of L. P. evaporators; types of evaporator plants, listing of advantages of L. P. submerged tube evaporators. Line diagrams illustrate principles brought out in descriptions. Typical installations are considered and analyzed; 12 pages. Condenser Service and Engineering Co., Inc.

70 **Power and Industrial Equipment**—Bulletin Q-12; describes and illustrates company's equipment for power and industrial use—steam turbines, motors, generators, feedwater heaters, turbo-chargers, steam jet ejectors, centrifugal blowers. Exceptionally well illustrated; 20 pages. Elliott Co.

71 **Heat Exchanger**—This new bulletin describes the company's Twin G-Fin Section; Bulletin 1614; section characterized as universal heat exchanger. Bulletin tabulates 21 features and corresponding advantages, describes design and construction. Installation views shown, field reports included; 16 pages. The Griscom-Russell Co.

72 **Evaporators**—Bulletin 364 describes, illustrates exporators for various capacities and pressures; contains sections of special interest to plant engineers and executives; includes explanation of functions of evaporators, benefits obtained by their use; different types of evaporating systems and their association with plant balance. 26 pages. The Griscom-Russell Co.

73 **Soot Blowers**—Bulletin F45; soot blowers in general are described. Description and operation of units, materials and specifications and other pertinent information is presented; tables of steam consumption, boiler efficiency, fuel saving chart; boiler cross-sections with blower locations indicated thereon and installation drawings and data are included; 10 pages. Marion Machine, Foundry & Supply Co.

74 **Water Heater Capacity Ratings**—14 tables are included in this ratings booklet showing capacity ratings per hour for temperature rises of from 20 deg (50 to 70 deg) up to and including ratings for a 150 F temperature rise (50 to 200 F). Table No. 15 presents the rate of flow of steam through pipes with steam from an initial gage pressure of one pound up to 150 psi. Marion Machine, Foundry and Supply Co.

75 **HP Extraction Heater**—Bulletin M-302 describes and illustrates the company's patented high pressures closure, Multilok. The features and advantages of the closure as compared to other types of construction are fully described in this 8 page bulletin. The Lummus Co.

76 **Coal Weighing Scales**—Description; outstanding features, specifications, line drawings, photos; 4 pages. Beaumont Birch Co.

77 **Rack and Pinion Gates for Coal and Ashes**—Ball-bearing, dust-tight features; photos, specifications, drawings, tables of dimensions; 4 pages. Beaumont Birch Co.

78 **Steam Specialties**—Collection of folders; steam trap, air trap, reducing valves, classes E, B and H pump governors, automatic boiler feedwater controller; parts and units list prices; descriptions; illustrations; tables of capacities. The C. E. Squires Co.

79 **Deaeration**—Data book; No. N-15 gives reasons for and principles of deaeration; cold water deaeration; tabular drawing and chart material presented; well illustrated; 20 pages. Elliott Co.

80 **How to Choose a Steam Trap**—Trap selection, trap rating, trap capacity factors, individual trapping, determining lift; traps for unit heaters, pipe coils, fan system heating surfaces, steam jacketed kettles, autoclaves, laundry equipment, paper makers, etc.; installation, operation, maintenance, instructions; specifications and capacities, corrosive service; 42 pages. The V. D. Anderson Co.

WATER TREATMENT

81 **Index for Calcium Carbonate**—Reprint of paper by John W. Ryznar; tables and charts; 16 pages. National Aluminate Corp.

82 **Boiler Feedwater Q & A**—Bulletin 30; 102 questions and answers on various problems of boiler feedwater; 16 pages. National Aluminate Corp.

83 **Water Treatment**—Scale and corrosion control in potable water supply; reprinted paper presented by Hanlon, Steffen, Rohlich and Kessler; 12 pages. National Aluminate Corp.

84 **Water Conditioning Service**—"The 6 Fundamentals of Betz Water Conditioning Service" illustrates and describes how this company extends a supervisory service for boiler water conditioning. Booklet shows complete operation of these 6 steps; 16 pages. W. H. & L. D. Betz.

85 **Water Softener**—Bulletin 607; benefits and economies of soft water; typical applications; how it works; types; design and features; backwash and brine rinse regulators; how to modernize present softener; aerators, degasitors, chemical feed systems, chemicals; 20 pages. Elgin Softener Corp.

86 **Softener Handbook**—Manuel, semi and full-automatic zeolite water softeners are covered in Bulletin 315. Water softener plant is discussed in the first section and operating cycles and plant supervision is next considered. The third section is "Selecting Manual or Automatic Equipment"; this is accompanied by a table of comparison data. Graver Tank & Mfg. Co., Inc.

87 **Sludge Reactivator**—Illustrated booklet, 8 pages, fully explains the principle of upward sludge filtration and describes its adaptability to industrial and municipal water supplies. Charts, flow diagrams and cut-away drawings show clearly how equipment softens and clarifies raw water, materially reduces reaction time and provides, in many cases, a water that is suitable for process work without further treatment. Graver Tank & Mfg. Co., Inc.

88 **Hot Process Water Treatment**—Form 326 is a case study bulletin; covers results of an installation of the company's hot process equipment at Kankakee Ordnance Plant. System was designed to provide 60,000 gph of properly conditioned water, free from hardness, scale forming minerals and corrosive gases. Graver Tank & Mfg. Co., Inc.

89 **Water Treatment**—Control of Fouling Organisms in Fresh and Salt Water, by John G. Dobson. Life history of these organisms; method of control. Wallace & Tiernan Products, Inc.

90 **Industrial Water Treatment**—Microbiological Control of and Through

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High grade gas, by-product and steam coal from Wise County, Va., on the Interstate Railroad.

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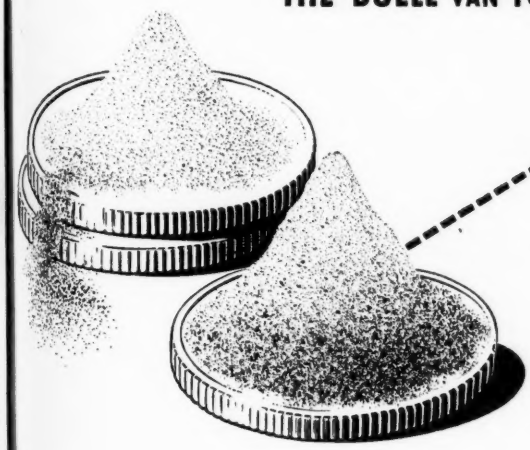

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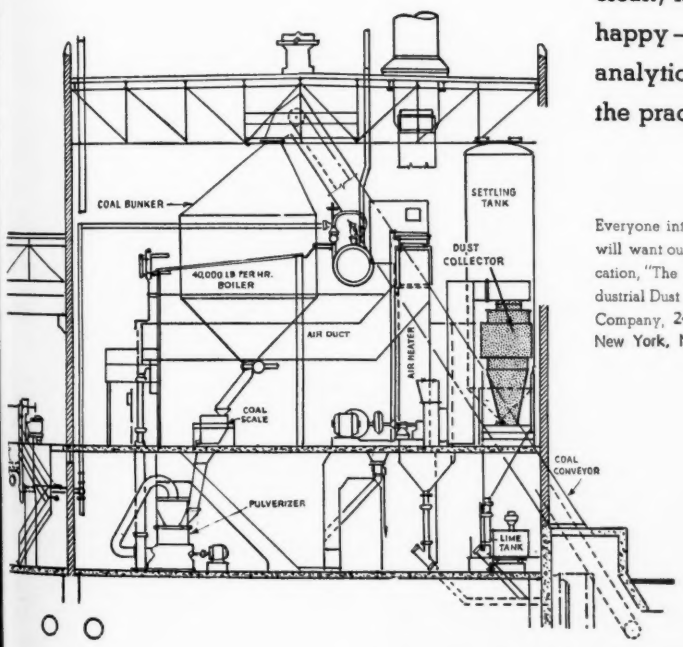
...in all-'round adequacy

A Buell Cyclone traps the coarse cinder particles, as only a cyclone can...and it traps the low-micron-size fines, as only a cyclone with the van Tongeren "Shave-Off" is able.

Fly-ash ceases to be a problem. The plant is clean; the neighborhood, likewise. Everyone is happy—and most of all the engineer whose analytical judgment found that Buell supplied the practical answer at a practical cost.



Everyone interested in Fly-Ash Collection will want our booklet of theory and application, "The van Tongeren System of Industrial Dust Recovery". Buell Engineering Company, 24 Cedar Street, Suite 5000, New York, N. Y.

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Engineered Efficiency in DUST RECOVERY

Industrial Waters; spot summaries of improvement of process efficiency and product quality of proper sterilization. Wallace and Tiernan Products, Inc.

91 **Condenser Water Treatment**—Chlorination of Condenser Cooling Water, by R. B. Martin; important consideration in chemical treatment of cooling water circuits. Wallace & Tiernan Products, Inc.

92 **Water Treatment**—Chlorine Destroys Ammonia, by A. E. Griffin. Gives data on use of chlorine for elimination of ammonia from boiler feed water. Wallace & Tiernan Products, Inc.

93 **Clarifying and Softening Water**—Eight-page catalog "Reactivator for Clarifying and Softening Water by Upward Sludge Filtration." First part of the booklet tells how the reactivator works and how the sludge blanket is kept in control so as not to flow out with the clarified water. Line diagrams illustrate the principle of operation. Graver Tank & Mfg. Co., Inc.

94 **Feed Water Treatment**—This four-page folder tells how the company's engineering applied to boiler feed water problems can result in savings. It tells of the different procedures and presents diagrams of equipment arrangement. Typical installations in dairy, cosmetic, aircraft, laundry, and other plants are pictured. Illinois Water Treatment Co.

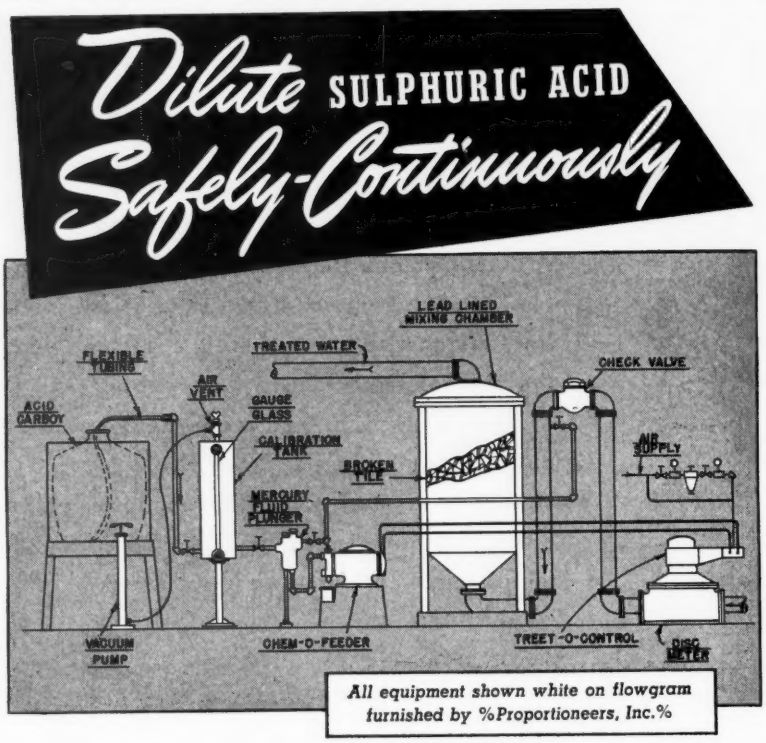
95 **Chemical Feeding and Proportioning**—Bulletins 1100 and 1713A; use of adjustable chemical feeder for water treating, sewage, chemical processes, petroleum; plan and sectional diagrams; descriptions; photos; general specifications; 2-page table of capacity schedules; list of chemicals handled; accessories; drawings of boiler water conditioning systems; 5-page description of method of automatic intermittent feed of conditioning chemicals direct to the boilers; 20 pages. Proportioneers, Inc.

96 **Automatic Proportioning**—Bulletin 1200, 28 pages. Handy reference book containing wealth of information on automatic flow responsive equipment and methods in continuous process operation. Photos of equipment and installation are supplemented by many flow diagrams and detail drawings. Complicated subject made exceptionally clear and understandable by careful arrangement and two-color diagrams. Proportioneers, Inc.

97 **Chemical Proportioning Equipment**—Bulletin 1714 covers chemical proportioning equipment for sea-going service. Two units—for high or low pressure—are described fully. Tabular material assists in the description. Proportioneers, Inc.

98 **Water Conditioning Instruction Booklet**—Bulletin 28X6385 was written especially for guidance of power plant operators. It touches upon importance of feedwater control, care of testing equipment, obtaining samples, test procedures. Handy reference tables given as aid to reporting results. Allis-Chalmers Mfg. Co.

99 **Complete Water Conditioning Service**—This four-page bulletin describes this company's complete water conditioning service—analysis, design fabrication, installation and maintenance of water treating equipment. Typical installations are pictured and brief sketches of the men behind the service are given. Graver Tank & Mfg. Co., Inc.



All equipment shown white on flowgram furnished by %Proportioneers, Inc.%

Water treatment and process requirements frequently involve the addition of diluted sulphuric acid or caustic to a water supply, either at constant rate or in response to flow variations. Flowgram illustrates a method developed by %Proportioneers, Inc.% for automatically performing this operation with the utmost safety and accuracy. Stratification in feed lines is avoided by complete mixing and concentrated acid is fed directly from the carboy into the system without further handling. All stuffing boxes are eliminated by the use of indirect displacement mercury plunger.

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COATINGS, TREATMENT

100 **Protective Coatings**—4 page folder 844-246 describes Bitumastic Hi-Heat Gray, a specialized industrial protective coating which is said to resist corrosion and temperature up to 1200 F. The folder is in 2 colors and contains several photographs of equipment on which Bitumastic has been applied. It also gives a list of uses for the material and a chart giving its characteristics. Walles Dove-Hermiston Corp.

101 **Fuel Oil Traatment**—A 4-page bulletin, telling about the company's treatment for fuel oil called "No Sludge." Advantages of using the treatment such as stepping up efficiency and reducing operating costs are explained. A list of dosages and applications is also given. A free test offer of the treatment is explained on the first page of the bulletin. Dominion Chemical Co., Inc.

102 **Flue Cleaner**—The company's soot and fire scale removing compound is described in this six-page folder. Results obtained from the use of this compound are described in the first part of the folder and then a list of the things which the company guarantees the material will accomplish are listed. Tables of dosage are presented and another table shows losses due to soot and fire scale. Dominion Chemical Co., Inc.

103 **Boiler Rust Treatment**—This four-page bulletin describes the company's "Rustoff" chemical which is said to "build resistance to rust and scale corroded and congested pipes." The bulletin tells how the treatment works and what results may be expected from its use. A brief description of the company's service department is included. Dominion Chemical Co., Inc.

104 **Fuel Oil Treatment**—Several bulletins have recently been announced by this company describing completely the application and effect of its fuel oil treatment compound and Diesel engine solvents. Wilcolene Mfg. Co.

HEATING, COOLING

105 **Cooling, Heating, Air Conditioning**—Collection of bulletins; installation, design, construction data, capacity ranges, condensed physical data, numerous photos of installations, full page color diagrams of flow of air, compressed air, water, water spray, etc. Niagara Blower Co.

INSULATION

106 **Industrial Insulations**—Block, blanket insulations; pipe covering; new pressure coverings; insulating cement; felt; Koldboard; fill insulation; diatomaceous earth products; uses, specifications, applications, preparation; charts; photos; list prices; 26 pages. Baldwin-Hill Co.

107 **Insulating Cement**—Ease of application, efficiency; ease of maintenance application recommendations; heat loss calculations, 4 pages. Baldwin-Hill Co.

STOKERS

108 **Air-Cooled Stoker**—Catalog R-A; features of construction; how timing device works; installation drawings, ash discharge, air cooling features; features of front end driving mechanism; engineering data tables; 20 tables. American Engineering Co.

109 **Water-Cooled Stoker**—Catalog W; drawings of installations; features; furnace views; 8 pages. American Engineering Co.

110 **Spreader Stoker**—Installation views; features of various parts; cross-sectional view of furnace with installation; listed features; 8 pages. American Engineering Co.

Piping News EXTRA 1947

LADISH ANNOUNCES AN IMPORTANT NEW DEVELOPMENT

A SEAMLESS REDUCING ELBOW

Patent Applied For

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SAVES WELDING COST

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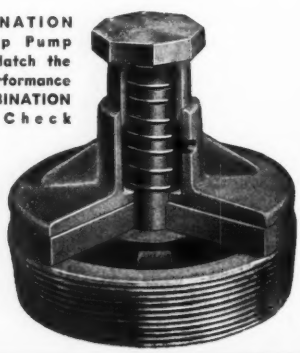

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111 Pneumatic Spreader Stoker—Three-fold booklet on the inner pages of which there are 30 spirally-bound vertical pages which fold back to tell the story of the stoker, installation, features, construction, principles, engineering, types and models, typical installations; well illustrated; 33 pages. Iron Fireman Mfg. Co.

112 Poweram Stoker—Bulletin 7121; essentials of successful stoker; fuel control, fuel conveying, fan capacity, controls, installation; illustrations; 18 pages. Iron Fireman Mfg. Co.

113 Coal Reference Bulletin—Bulletin 8, Underfeed Stoker Firing, Bulletin covers factors involved in selection of multiple retort stokers, principles, design data and drawings of typical installations; 6 pages. Fairmont Coal Bureau.

114 Stoker Firing Operation—Single Retort Underfeed Stoker Firing is the subject of Bulletin Number 9 issued by this Bureau. It is a complete analysis of the advantages of the single retort stoker in the smaller plants. Types of this stoker are described and principles of operation are outlined. Fairmont Coal Bureau.

OIL, GAS BURNERS

115 Wide Range Oil Burning System—Bulletin 109; How the system operates; control, drawings; 4 pages. Peabody Engineering Corp.

116 Oil Burners—Bulletin 108; Two types of oil burners, A and H; air registers, oil atomizers, drawings; 4 pages. Peabody Engineering Corp.

117 Gas Burners—Bulletin 203; description of A and H gas burners; cross-sectional diagram; photos of atomizers; 4 pages. Peabody Engineering Corp.

OIL, LUBRICATION

118 Lubrication Recommendations—Special oils for Diesels and heavy-duty gasoline engines; facts about oil; tables of recommended oils for various models; 18 pages. Standard Oil Company of California.

119 Cutting Fluids—Facts about cutting fluids; machine tool operations; fundamentals of cutting; how to apply; metallic cutting tools; tabular material; shop practices; 50 pages. Standard Oil Company of California.

120 Diesel Operation—Relation of fuels and lubricants to the operating efficiency of the diesel engine; diesel fundamentals; maintenance; lubrication and fuels; supercharging; selection and classification of fuels; fuel injection maintenance; improving cleanliness; tabular material, charts, formulas; 114 pages. The Texas Co.

121 Engineers Report on Oil—Engine tests, laboratory tests, effects on engines, bearing corrosion, actual service data, filter clogging, service experience; well illustrated with photos and charts; 42 pages. Standard Oil Company of California.

122 Lubricants Service Handbook—28 pages in this booklet on lubricants and their application. The development of the lubricant, its features and advantages and the manner in which it meets various operating conditions take up the fore part of the booklet. "Recommendations" section where the manufacturer tells just what grease or oil should be used according to speeds, temperatures, pressures and general service conditions is given. Fiske Brothers Refining Co.

123 Oil Products for Industry—Cutting oil, processing oils, general lubricants, refrigeration oils, Diesel oils, solvents, greases and waxes are among the petroleum products for industry which are described in this four-page folder. The various grades of each oil are analyzed and the reasons why they are fitted to each particular job are given. Sun Oil Co.

124 Lubricania—The hundreds of specialized lubricants in use today are identified by certain commonly used tests and terms which describe their physical characteristics. In this dictionary of terms, tests and values, the company has highlighted the most important of these. Tide Water Associated Oil Co.

POWER TRANSMISSION

125 Speed Reduction, Increase Gear—Bulletin S-130; description; gear cases; gear and pinion; bearings; lubrication; drawings and photos; 8 pages. The Terry Steam Turbine Co.

126 V-Belt Drive Guide—Bulletin B6051F; guide to company's complete line of V-belt drives. Contents include types and sizes. V-belt prices, how to figure drives, belt selector charts and tables and similar engineering information. Well illustrated; 12 pages. Allis-Chalmers Mfg. Co.

127 Flexible Couplings—Bulletin 57; 2 pages of drawings and tables of ratings for company's flexible couplings. Installations are shown and features of the various types are discussed; 20 pages. John Waldron Corp.

VALVES

128 Regulating Valve—Bulletin 1-A; valve data book, description, dimensions and lists of parts; typical installations, rated capacities; prices; 52 pages. Atlas Valve Co.

129 Pressure Regulator—Bulletin 1-B; description, installation, operation; list prices; sectional and installation views; parts lists; 8 pages. Atlas Valve Co.

130 Pressure Reducing Valve—Bulletin 1-C; sectional drawings, list prices, dimensions and weights; operation and adjustment; capacities for steam and air; 12 pages. Atlas Valve Co.

131 General Service Valve—Bulletin E-150; valves for blow-off; fire protection, soot blower lines, acids, process etc.; description; exploded views; features; dimensions, weights and list price tables; parts and parts lists; 14 pages. Everlasting Valve Co.

132 Valve—Bulletin E-100; for boiler room service; photos, descriptions, parts; features; pressure rating indexes; size, shipping weight and price tables; ordering information; 30 pages. Everlasting Valve Co.

133 Multiport Relief Valve—Bulletin 4150; complete description of valves and operating characteristics, photographs of typical installations. Engineering data includes sizing information tables, nomenclature, installation and operation, list of prices of accessories, dimensioned drawings and tables of dimensions; 28 pages. Cochrane Corp.

134 Diaphragm Motor Valves—24 pages. Covers Why and How of unit's design. Materials specifications given as are two pages of engineering information and charts. Kieley & Mueller Inc.

MAINTENANCE

135 71 Maintenance Jobs—This guide tells how better to perform commonly occuring power plant maintenance and cleaning operations. Illustrated manual gives specific material and method recommendations for handling cleaning, degreasing, descaling, derusting, paint stripping, etc. Booklet is completely indexed and reference is made by colored type strips on edge of the pages; 22 pages. Oakite Products, Inc.

136 Protecting Metal—High heat resistant coatings for protecting metal surfaces in power and processing equipment are covered in 4 page bulletin. Brief description of properties of coatings are given. The Dampney Co. of America.

137 Condenser Tube Inserts—Description of Flowrites; illustrated, accompanied by report of tests on Flowrites made by M.I.T. Tables and charts of test results are presented; description of how to install inserts given; 8 pages. Condenser Service & Engineering Co., Inc.

CONTROLS, METERS

138 Damper Regulators—Bulletin 4-A; for low pressure heating, medium pressure power and high pressure power boilers; what they do; how to specify; typical installations (drawings); adustments; list prices; technical descriptions and parts lists; 20 pages. Atlas Valve Co.

139 Thermostats and Relays—Bulletin T, a 12 page catalog presents significant information on this company's mercurial thermostats and adustable thermoregulators. Also included is complete data on relays, designed as companion instruments to the above mentioned. Complete descriptions of the instruments are included and the bulletin is well illustrated. Precision Thermometer & Instrument Co.

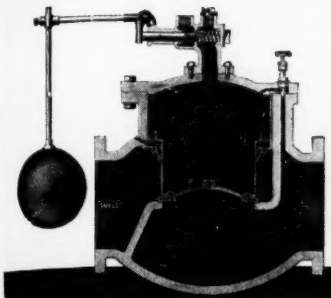
140 Recording Flow Meter—Bulletin 349; what it does, features, chart of rated capacity; construction and operation; installation drawings, tables of capacity; photos; 8 pages. Builders-Providence, Inc.

141 Propeller-Type Meter—Bulletin 350A; for main-line metering; applications, description, installation, materials of construction; features; table of capacity, shipping weights; specifications, drawings; 4 pages. Builders-Providence, Inc.

142 Centralized Combustion Control—Bulletin 43-605; application to various types fuels and burning equipment; controller, measuring elements, pilot device, power unit, etc.; 24 pages. The Hays Corp.

143 Combustion Meters—Bulletin 44-550; reasons why it is accurate, dependable, simple, rugged, easy to install, easy to maintain, speedy, easy to understand; well illustrated by explanatory diagrams; 16 pages. The Hays Corp.

144 Feedwater Textbook—"Mechanical Feedwater Regulation for Boilers" by



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Prof. E. P. Culver; principles of feedwater regulation; mechanical equipment available; differential pressure control; feed pump control; illustrations, diagrams, charts; 36 pages. Northern Equipment Co.

145 **Engineering Monographs** — Series of eight on automatic combustion control: 1. How Close Can Steam Pressure Be Controlled? 2. Why Operate Automatic Combustion Control from Changes in Steam Pressure? 3. Adapting to the Characteristics of Underfed Stokers. 4. Adapting to Spreader Type Stokers. 5. Adapting to Chain or Traveling Grate Stokers. 6. Adapting to the Characteristics of Pulverizers. 7. Adapting to the Characteristics of Oil Burners. 8. Adapting to the Characteristics of Gas Burners; total 37 pages. The Hays Corp.

146 **Draft Gages**—Bulletin 46-667; gages for indicating, recording of drafts, pressures, differentials, temperatures; pressure-draft tables; description of equipment; differential units, Bourdon tube units, pointer gages, etc.; 20 pages. The Hays Corp.

147 **Draft**—Bulletin 46-472; what draft is; where it is found; how it is measured; what the draft gage tells, where to measure draft and pressure in steam plant; where to connect draft gages; how to install; drawings; 20 pages. The Hays Corp.

148 **Flue Gas Analyzer**—Bulletin 45-668; principle of operation; construction features; technique; models and prices; Burrettes—classifications and uses (table); what flue gas analysis tells us; 16 pages. The Hays Corp.

149 **Indicating, Control Systems** — What they are, what they can do; Bulletin 14B6641. Description of how transmitter, receiver and indicator of systems are constructed, how they work, their advantages and specifications. Illustrated with photographs, diagrams, charts; 12 pages. Allis-Chalmers Mfg. Co.

150 **Water Gages** — Condensed catalog, Bulletin E, of company's complete line of water gages. Each model illustrated and accompanying table gives sizing information; 8 pages. Ernst Water Column & Gage Co.

151 **Stainless Steel Bellows** — Bulletin SSB-46; contains diagrammatic cross-section views and up-to-date information concerning the use of these bellows as equalizers, compensators, expansion joints, flexible connectors for flow control, vapor and steam traps, thermostatic instruments, etc. Completely illustrated; 12 pages. Chicago Metal Hose Corp.

152 **Pitot Equipment**—Three section Bulletin 50; gives complete details of the use of Pitot tubes and rods, instructions in the use of the company's portable Pitot recorder, together with theory, formulae, notations and curves. Completely indexed; 20 pages. Simplex Valve & Meter Co.

153 **Manometers**—Bulletin 200; describes completely this line of fixed and portable manometers for use in water surveys and similar flow rate measurement, valuable engineering data also included. Illustrations include line drawings and photographs; 8 pages. Simplex Valve & Meter Co.

154 **Instruments, Controls for Process**—Bulletin 17; process controllers, control components, measuring components and instrument combinations briefly described and illustrated. Application data such as sizes, pressure standards and ranges are listed; 8 pages. Bailey Meter Co.

155 **Temperature Regulators** — Bulletin 7-A; six types; descriptions; list prices, tabular material, photos; list of parts; typical installation drawings; tables for finding sizes of control valves required to heat given quantity of water; 16 pages. Atlas Valve Co.

156 **Draft, Excess Air and CO_2**—Bulletin 39-341; discussion of the relation of these elements to the installation and servicing of bituminous and anthracite stokers by Arnold Soller; 12 pages. The Hays Corp.

157 **Liquid Level Controllers** — Bulletin A-100 is a four-page catalog describing this company's Types G and D liquid level regulators. Excellent cross-sectional views of the units are presented and their operational and constructional features are described. Dimensions, capacities and shipping weights are presented. Stets Company.

158 **Boiler Feed Control**—Bulletin 463, 16 pages, describes boiler feed control systems at Westover, Greenidge and Jennison Stations of N. Y. State Electric and Gas Corp. Completely illustrated with photos and line drawings. Tables of significant data included. Northern Equipment Co.

159 **Water Level Control** — "Controlling Water Level on Combustion Engineering Type VU Boiler," is title of Bul-

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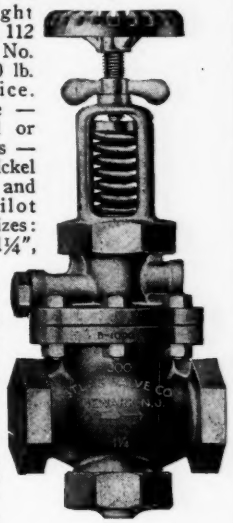

At the right we show Fig. 112 (see Bulletin No. 1-A) for 300 lb. steam service. All bronze — Screwed or Flanged Ends — Bronze or Nickel Alloy Seats and Valves — Pilot Operated. Sizes: ½", ¾", 1", 1¼", 1½", 2".

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And for 400 and 600 lb. service see pages 10 and 12 of Bulletin 1-A. These valves are for temperatures to 900° F. Series 40 is for steam service to 400 lb. while series 60 is for steam service to 600 lb. Steel Body—Stainless Steel and Nickel Alloy Seats — Nitralloy Piston and Stainless Steel Piston Chamber—Flanged Ends—Pilot Operated. Sizes: ½", ¾", 1", 1¼", 1½", 2", 2½", 3", 4".

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letin 455. These four pages present photos and chart reproductions and tell the details of the company's control equipment on this particular type of boiler. Northern Equipment Co.

160 **Water Level Control**—Bulletin 459, 8 pages, description of water level control installation at Wyman-Gordon Co. Good illustrations show details of installation. Table of significant data given. Northern Equipment Co.

161 **Boiler Water Level Control**—Bulletin 467 and 465, 8 pages each, describe respectively, control installations at Buzzard Point Plant and West Reading Station. Both give exceptionally detailed reports of the installation complete with tables, photos and drawings. Northern Equipment Co.

PACKING GASKETS

162 **Packing**—Bulletin 237; photos and descriptions of use; installation drawings; standard size table; 4 pages. Warren Steam Pump Co., Inc.

FITTINGS

163 **Standards for Flanged Fittings, Valves, Flanges**—Pressure temperature ratings, tables and charts, rating procedure, flange materials, safety factors, loading, stress formulas; 20 pages. Tube Turns, Inc.

164 **Welding Fittings**—Allowable working pressures; power, oil, district heating, refrigeration, gas and air piping; 14 tables and directions for use; 18 pages. Tube Turns, Inc.

165 **Welding Fittings**—Volumetric capacities, 2 pages of formulas for computation of capacities; 6 pages of tables; 12 pages in book. Tube Turns, Inc.

166 **Unions**—Complete line of malleable iron unions and convenience unions; illustrations, descriptions, size and list prices; descriptions of materials and workmanship; 24 pages. Jefferson Union Co.

PUMPS

167 **Horizontal Duplex Piston Pumps**—Bulletin 230-1; specifications, steam end, liquid end; capacity tables for pressure service, light pressure service; dimensions, drawings, tables; 4 pages. Warren Steam Pump Co., Inc.

168 **Steam Heat Vacuum Pumps**—Bulletin 226-1; specifications, drawings, general information, tables of sizes and capacities; 4 pages. Warren Steam Pump Co., Inc.

169 **Centrifugal Pumps**—Bulletin 302-30, Revised; instructions for installation and operation; drawings, tabular material; 12 pages. Warren Steam Pump Co., Inc.

170 **Hydraulic Pressure Pumps**—Bulletin 238; specifications, sectional photos, important features; full page table of capacity, sizes, pipe sizes, pressure; 4 pages. Warren Steam Pump Co., Inc.

171 **Screw Pumps**—Recommended uses; advantages; tables of capacities and sizes; charts of test results; dimensioned drawings; suctions and discharge, packing box sizes, shipping weights tables; specifications; installation and maintenance; theoretical horsepowers; viscosity classifications; 18 pages. Sier-Bath Gear & Pump Co., Inc.

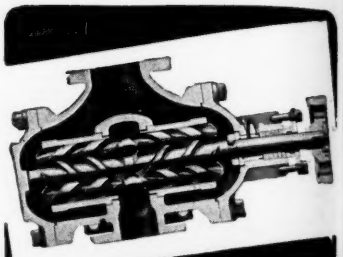
172 **Centrifugal Pumps**—Booklet describes basic action of centrifugal pumps, tells of the science of centrifugal action and the physics of pumping. Performance curves are presented. Descriptions of the company's self-priming centrifugal pumps are given and how they operate is explained. Typical use of the units are pointed out and installation and operation explained; 20 pages. Marlow Pumps.

173 **Centrifugal Pumps**—Bulletin 240, 6-page folder describing single stage, double suction, Type DBL centrifugal pump. Features of the pump resulting from its construction and engineering; a sectional view which is used to point out other advantages of the unit. Tables of metal specifications and capacity ratings in gallons are also given. Warren Steam Pump Co., Inc.

174 **Multi-Stage Pumps**—Bulletin 241 describes 4 and 6 stage Type TM pumps. Cross-sectional illustrations and tables of specifications are given. Dimensioned drawings and tables of dimensions accompany copy describing unit's construction and advantages. Warren Steam Pump Co., Inc.

175 **Close-Coupled Pumps**—Close-coupled pumps, called Compac-units, are described in Bulletin 242. This eight-page bulletin presents clear and understandable cross-sectional photos of the units and uses these to point out construction and operation features. A full-page "Composite Rating Table" presents rating information at various heads for 9 different models of pumps. Warren Steam Pump Co., Inc.

176 **Compressors, Vacuum Pumps**—Bulletin C-5; 16 pages. Describes complete



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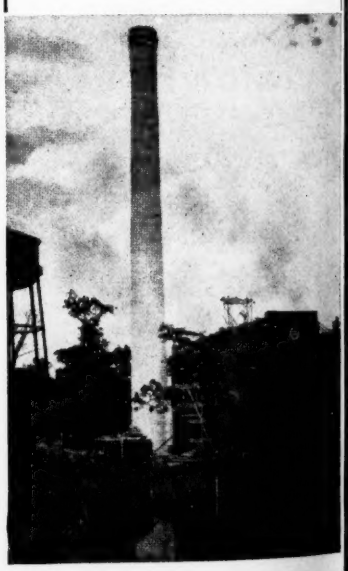

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details of construction including illustrative material such as photographs of parts of the units and drawings of detailed structural parts. Tables present size and capacity information. Chart of typical characteristics is given. Fuller Co.

MISCELLANEOUS

177 **Floor Resurfacing** — This recently-published folder describes the methods of use of the company's heavy-duty resurfacer for use on floors, traffic aisles and loading platforms. It contains a concise, clear description of the properties, methods of application and advantages of the resurfacer and is of interest to everyone who has problems in the maintenance and repair of concrete floors. Stonhard Company.

178 **Electric Tools**—Bulletin 464; covers complete line of portable electric tools for construction and briefly describes such tools as electric hammers, drills, chisels, vibrating tools, accessories, screw drivers, etc. Prices are given. Syntron Co.

179 **Refractory Concrete**—"Lumnite for Refractory Concrete"; basic information on materials and methods used in making refractory concrete. Illustrations show application of concrete in construction of furnaces, coke ovens, etc. Lumnite Division, Universal Atlas Cement Co.

180 **Gas Purger for Refrigeration System** —Bulletin 160; tells how to cut power costs and raise condenser capacity by proper purging of non-condensible gases. Tables of ammonia properties, advantages and complete illustrated material. 8 pages. Armstrong Machine Works.

181 **Grinding Wheels** — Grinding wheels of various abrasives are illustrated and list prices presented; tables of sizes in inches are accompanied by photographs and line drawings of these various wheels. Grinding wheel dressers with list prices are shown; 32 pages. Norton Co.

182 **Weldments**—Bulletin SP106 tells about the services of this company's weldry and the weldments turned out therein. The products of this weldry are shown and the text points out how flexible the method is. Graver Tank & Mfg. Co., Inc.

183 **Drop Forged Flanges**—Manufacturing processes; physical characteristics; full-page tables of illustrations, dimensions, weights and prices. Space provided for future insertions. Phoenix Mfg. Co.

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STATEMENT of the ownership, management, circulation, etc. required by the acts of Congress of August 24, 1912 as amended by the acts of March 3, 1933, and July 2, 1946, of POWER PLANT ENGINEERING, published monthly at Chicago, Illinois, for October 1, 1947.

State of Illinois, } ss.
County of Cook, }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Kingsley L. Rice, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the POWER PLANT ENGINEERING and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily, weekly, semiweekly or triweekly news paper, the circulation) etc. of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933, and July 2, 1946 (section 537, Postal Laws and Regulations), printed on the reverse of this form, to wit:

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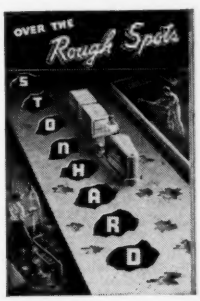

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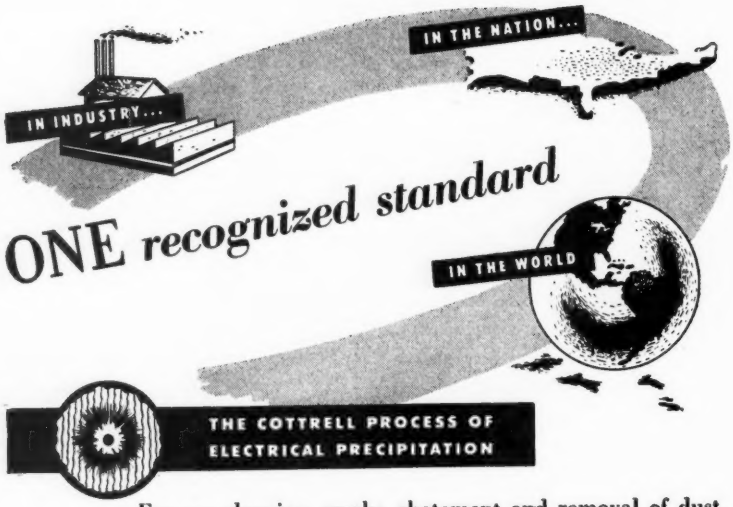

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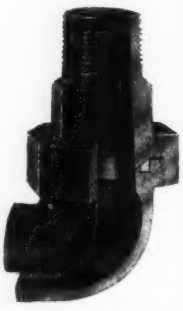

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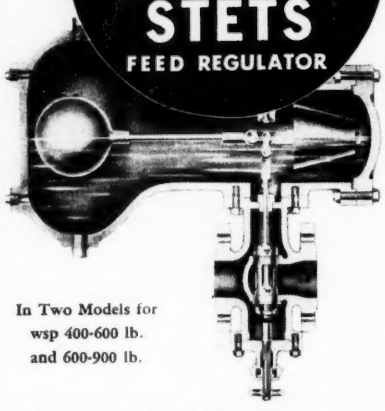

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New ENGINEERING BOOKS

The Magic of Numbers, by Eric Temple Bell; first edition, 418 pages, 5½ by 8 inches, cloth; published by Whittelsey House, McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York City, 1947; price $3.50.

This is a book **about** mathematics, not on it. In it the author gives you a human history, the living biography of the men who played and still play so great a part in this one great scientific development. Filled with matchless wit and insight the story covers some 3000 years beginning with the theory of Pythagoras and ending with a discussion of the work and developments of present day physicists such as Eddington and Einstein. It tells how colossal intellects appealed to numbers for verification of the natural order of things, how some were honored, others put to the torch.

The book takes you through the great 17th century when Galileo and Newton setup their theory of experiment and observation to prove or disprove traditional concepts of natural phenomena. It interprets the origin of the return to the Pythagorean principle of reasoning by pure mathematics which is now proving the basis for the development of new wonders. Prof. Bell writes easily and in-

terestingly. Anyone who has any interest in mathematics at all will find this book not only of value but interesting and amusing. It is a story of how number magic has influenced the development of religion, philosophy, science and mathematics and the struggle of human beings through history to give an understandable account of the infinite. The author is Professor of Mathematics at the California Institute of Technology and has written a number of other interesting books dealing with the subject of mathematics in a popular way.

Principles of Electrical Engineering by T. F. Wall; 576 pages, 5½ by 8½ inches, cloth, illustrated; published by Chemical Publishing Co., Inc., 26 Court Street, Brooklyn 2, New York, 1947; price $8.50.

This book gives a comprehensive but compact account of the basic principles of the science of electrical engineering. The main idea throughout the book has been to place emphasis on the identity of the principles relating to both heavy current and light current engineering practice.

Methods of solution of a wide range of technical problems have been solved, new developments in application, testing and materials are fully covered. The book begins with a brief historical survey of the development of standards for units of measurements from the earliest days of the industry. Chapter Two deals with the structure of the atom, conductors and insulators, the electric current and electric resistance. Chapter three takes the reader into Coulomb's law, fields of electric force and electric potential. From there on the book covers the entire range of electrical engineering closing in chapter sixteen with an account of the propagation of electromagnetic waves through space. Together with an accompanying companion volume "Electrical Engineering Problems and Their Solutions," this book offers a complete course in electrical engineering for students and practicing engineers. The author is Lecturer-in-Charge, Department of Electrical Engineering, University of Sheffield in England.

Electrical Engineering Problems and Their Solutions by T. F. Wall; first edition, 312 pages, 5½ by 8 inches, cloth, illustrated; published by Chemical Publishing Co., Inc., 26 Court Street, Brooklyn 2, New York, 1947, price $5.00.

This book is the companion volume to Dr. Wall's "Principles of Electrical Engineering" just published. The examples in this book have been chosen and arranged to emphasize the different aspects of the principles dealt with in the various chapters of that book and to make clear points which might otherwise be obscure. Detailed solutions of problems have been drawn from the entire field of applied electricity and magnetism including both light and heavy currents. The questions and answers have been taken from actual practice. While most of the problems can be solved by the average intelligent reader there are a considerable number of problems which will extend the facilities of the most brilliant reader to work out solutions in full detail. This book is one of the few books that gives complete and detailed solutions to practically all types of electrical problems.

The Evolution of Modern Physics by Carl Trueblood Chase; first edition, 203 pages, 5¾ by 8½ inches, cloth, illustrated; published by D. Van Nostrand Co., Inc., 250 Fourth Avenue, New York 3, New York, 1947, price $2.50.

From the first page to the last, this book maintains the fundamental scientific outlook, the motivation that activates basic research by showing the clear steps in logic which lead from the discovery of one fact or principle to another. It gives to every reader a broad framework for a full understanding of the present day world of the physical scientist, the history of its past development and its trend into the future. In addition to its major topics, the book explains hundreds of important subjects, scientific laws,

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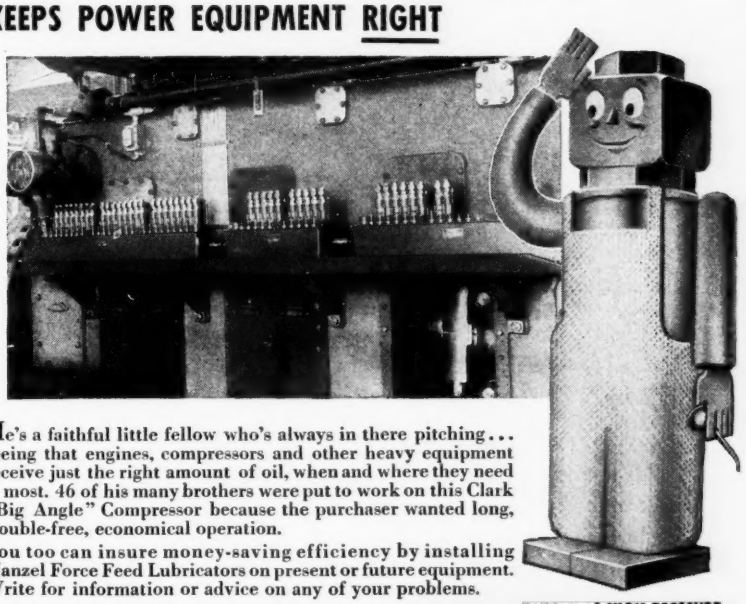

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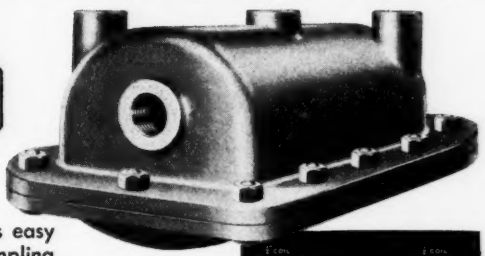

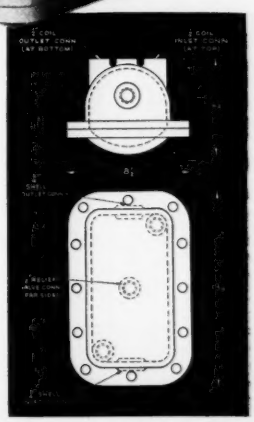

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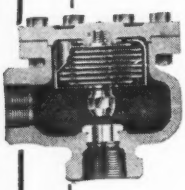

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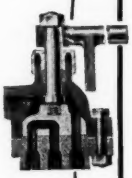

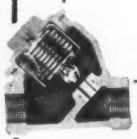

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Generators and Motors and Their Applications by D. J. Duffin; first edition, 210 pages, 7½ by 10 inches, cloth, illustrated; published by McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York, New York, 1947, price $4.00.

This book is a working manual for motor repairmen. It is a manual for practical, on-the-job use by armature winders and electric motor repairmen. It presents fundamental electric motor and generator theory and covers a wealth of important working data on a wide variety of parts and makes of alternating and direct current equipment. The book is the first of three working manuals for motor repairmen; the other two dealing with direct current armature winding and alternating current armature winding are now in preparation. While the book is intended for repairmen, this manual should also be of use to others who are not primarily interested in armature winding as a career but who wish to know more about the operation, maintenance, selection, characteristics and applications of motors and generators, plant owners, dealers in electrical equipment, salesmen, maintenance men, electrical contractors and their assistants: electricians, service men for power companies, building superintendents, building inspectors, vocational school students and users of electrical equipment. Teachers and students of industrial training programs and students of electrical engineering may also profit from the illustrated material in this book. The material has been drawn from a wide variety of sources including many of the more important manufacturers of electrical equipment in this country. While this book is the first of three similar manuals it is complete in itself.

Power System Stability, Volume II—Transient Stability. By Selden B. Crary; first edition, 330 pages, 5½ by 8½ inches, cloth, illustrated; published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1947, price $6.00.

The first volume of this book dealing with steady state stability was published in 1945. Now, the second volume dealing with transient stability makes its appearance. Like the first volume the book is addressed to power system and apparatus design engineers whose task as a group has now been greatly increased by the necessity of greatly increasing the electric generating and distribution capacity of this country. The author is in the Central Station Engineering Division of the General Electric Company at Schenectady and as the author points out in the preface much of the material in the volume has been worked out in co-operation with his associates at the General Electric Company.

The first six chapters of this second volume are devoted to methods of analysis and the next three to applications, in the last chapter the various types of stability are discussed and the term "Overall Stability" is proposed to indicate the necessary unity of the complete phenomena. Also in this chapter indication is given of the future possibility of control equipment, particularly, voltage regulators. The book is one of a series written in the interest of the General Electric Advanced Engineering Program.

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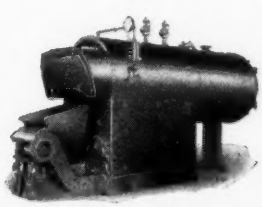

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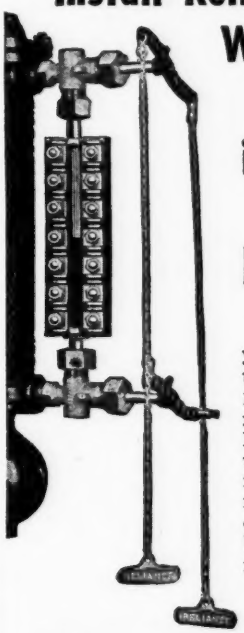

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DESCRIBING METHODS his company employs in maintenance of concrete hydraulic structures, A. C. Giesecke, hydraulic engineer, Minnesota Light and Power Company, Duluth, pointed to a 1906-built plant as "not only the oldest but the very best concrete structure on the company's property." Mr. Giesecke was addressing the power division of ASCE at its annual convention. Emphasizing the severe winters the concrete must weather in this area, Mr. Giesecke asked: "Was concrete of 1906 an art that was lost at a later date? It looks that way. Fortunately the record of this fine old structure, capable of enduring our severe climate, is available. It shows that great care was taken to use exact amount of mixing water for each batch of concrete. The design was developed in the laboratory by testing a great number of short unreinforced beams. So certainly the art of building concrete good enough for this climate was available when, later, the not-so-good work was done." He then presented photographs and charts in evidence. He recalled that the plants with highest restoration charges against them were built during "the days of World War I, or its aftermath, when we indulged in the slogan 'Concrete for Permanence,' a form of whistling in the dark, perhaps, and when the cry was 'hurry, hurry, build the plant.'"

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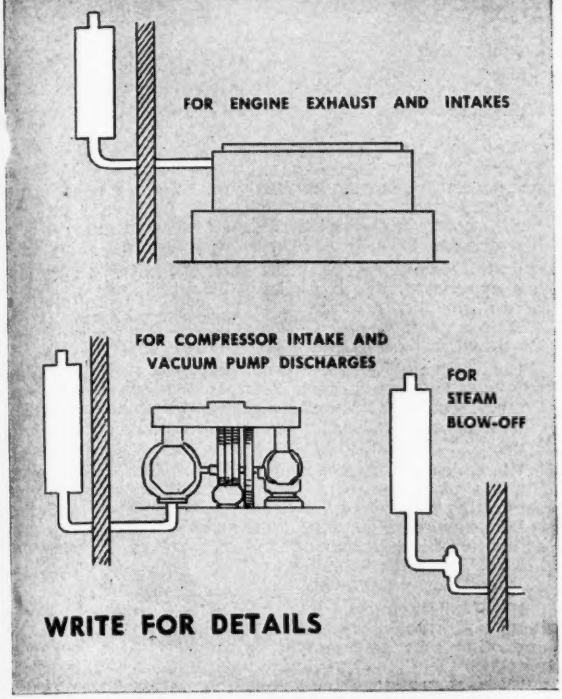

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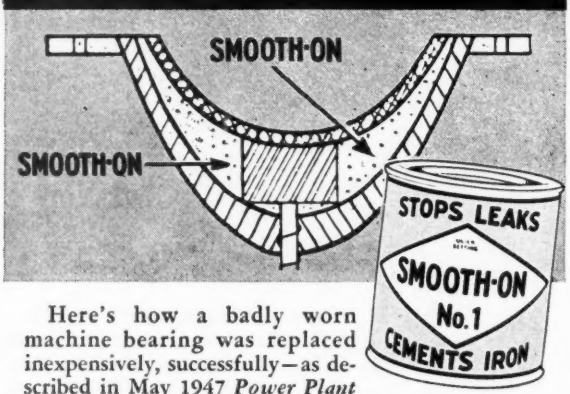

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POWER PLANT *Construction News*

Ark., St. Francis—Arkansas-Missouri Power Corp., Blytheville, Ark., has plans maturing for new steam-electric generating station in vicinity of St. Francis, estimated to cost about $5,000,000, including turbine-generators, high-pressure boilers, switching station and extensions in high-tension lines. Work on foundations will begin soon.

Conn., Hartford—Hartford Electric Light Co., Hartford, has approved plans for extensions and improvements in South Meadow generating station, with installation of additional equipment. Cost reported close to $2,000,000. Work will be placed under way soon.

Fla., Miami—Florida Power & Light Co., Miami, plans new electric-generating station on Ludlum Road, Dade County, vicinity of Miami, to cost approximately $350,000, with equipment. Ebasco Services, Inc., 2 Rector St., New York, N. Y., is consulting engineer.

Ill., Chicago—Commonwealth Edison Co., 72 W. Adams St., has plans maturing for new Midland steam-electric generating station and will begin work soon. Contract is being awarded for structural steel framing. No official estimate of cost announced, but reported in excess of $15,000,000, with turbine-generators, high-pressure boilers and auxiliary equipment.

Ind., Jeffersonville—Ashland Oil & Refining Co., Ashland, Ky., refined oils, plans pumping plant, boiler house and other mechanical facilities at proposed new oil terminal on Ohio River at Jeffersonville. Also installation of battery of pressure steel tanks for storage and distribution. Entire project reported to cost about $200,000. Work will begin soon.

Iowa, Dakota City—Corn Belt Power Cooperative, Hampton, Iowa, recently formed by merger of Federated Cooperative Power Association, Hampton, and Central Electric Federated Cooperative, Pocahontas, Iowa, plans new steam-electric generating plant in vicinity of fork of East and West Des Moines Rivers, near Dakota City (Humboldt County). It will be equipped with turbine generators, high-pressure boilers and auxiliaries for large output and is estimated to cost about $5,000,000. Work will begin in near future. Financing has been arranged through Federal aid.

Kan., Ulysses—Pioneer Cooperative Association, Inc., has plans for new electric generating station and will award construction contract at early date. No estimate of cost announced. Beavers & Lodal, Transit Tower Bldg., San Antonio, Tex., are consulting engineers.

Mich., Dearborn—Ford Motor Co., plans installation of electric power equipment, material-handling apparatus and other mechanical and electrical facilities in connection with expansion and modernization of steel and foundry departments, for which plans are now being prepared. A new blast furnace will be built. Entire program will be carried out over a period of months and will represent a gross investment estimated at $18,000,000. Arthur G. McKee & Co., 2300 Chester Ave., Cleveland, Ohio, is consulting engineer.

Mich., Jackson—Consumers Power Co., Jackson, is considering construction of a new steam-electric generating station on Lake Erie, in Southeastern part of State. Surveys and estimates of cost are being made. Company is arranging a 1948 expansion and improvement program in plants and systems to cost approximately $27,000,000.

Mo., St. Louis—Monsanto Chemical Co., 1700 S. Second St., industrial and other chemicals, has approved plans for new electric generating station for factory service, on site at 136 Lesperance St. Cost estimated close to $250,000. Erection will begin soon.

Neb., Alliance—Panhandle Rural Electric Membership Association, Alliance, plans new generating station in connection with line construction in Grant County. Entire project is estimated to cost close to $650,000. Financing will be arranged through Federal aid.

N. M., Taos—Kit Carson Electric Cooperative, Taos, has plans maturing for extensions and improvements in electric generating station, with installation of additional

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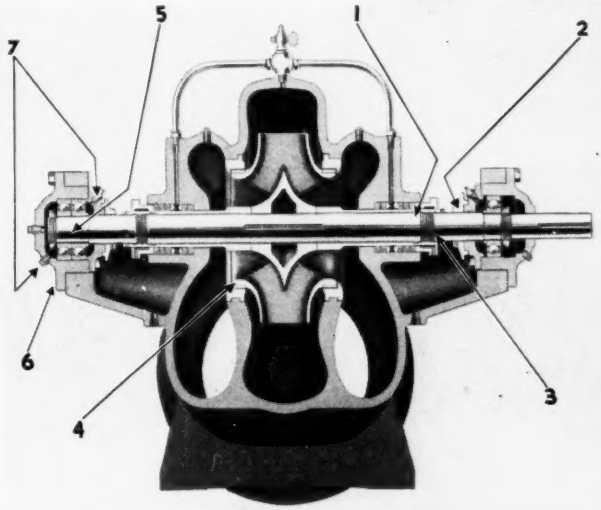

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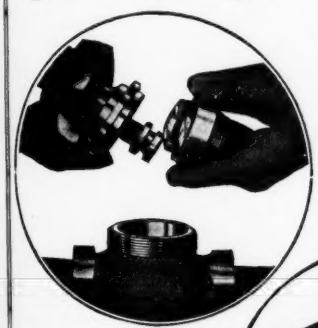

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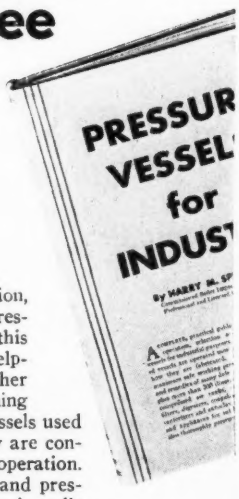

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equipment. No estimate of cost announced. Beavers & Lodal, Transit Tower Bldg., San Antonio, Tex., are consulting engineers.

N. Y., Lackawack—Central Hudson Gas & Electric Corp., Poughkeepsie, N. Y., plans new hydroelectric generating station in vicinity of Roundout Reservoir, New York water supply system, vicinity of Lackawack. No estimate of cost announced. Work is scheduled to begin in near future.

N. Y., Port Jefferson—Long Island Lighting Co., 250 Old Country Rd., Mineola, L. I., has plans in progress for new steam-electric generating station at Port Jefferson, reported to cost close to $3,900,000, with turbine generators, high-pressure boilers and other equipment. Ebasco Services, Inc., 2 Rector St., New York, N. Y., is consulting engineer.

Okla., Oklahoma City—Oklahoma Gas & Electric Co., Oklahoma City, plans new steam-electric generating station on site near city, with installation to include a 50,000-kw turbine-generator unit, high-pressure boiler and auxiliary equipment. Also will construct an addition to present Lincoln Beerbower generating plant, near Ponca City, with installation of new 25,000-kw turbine-generator, high-pressure boiler and miscellaneous equipment. This is part of a $14,000,000 expansion and improvement program now being arranged.

Ore., Coquille—Coos Electric Cooperative, Inc., Coquille, plans two electric generating stations in conjunction with extensions in rural primary and secondary lines. Entire program will cost about $450,000. Financing will be arranged through Federal aid.

Pa., Courtney—West Penn Power Co., 14 Wood St., Pittsburgh, Pa., has authorized expansion in new steam-electric generating station now in course of erection near Courtney, to be known as Mitchell power plant. Work will include installation of a second 80,000-kw turbine-generator, high-pressure boilers and accessory equipment. Initial plant units are expected to be ready for service by close of 1948, and other equipment, early in 1950. Entire project will represent a gross investment of about $25,000,000, including line construction.

Pa., Philadelphia—Joseph T. Ryerson & Son, Inc., 5200 Grays Ave., steel products, plans new boiler house at storage and distribution plant. Work will be carried out in connection with building extensions, entire project estimated to cost about $130,000. Proposed to begin work at once.

S. D., Beresford—Town Council has plans for addition to municipal oil engine-operated generating station, with installation of additional equipment for increased capacity. No estimate of cost announced, work will begin soon. J. E. Benson, Boyce Greeley Bldg., Sioux Falls, Iowa, is consulting engineer.

Texas, Corpus Christi—Central Power & Light Co., Corpus Christi, is arranging plans for expansion in generating stations during next 48 months, supplementing work now in progress to increase power facilities for an advance of about 20,000 kw. In 1948, it is proposed to duplicate power plant extensions a like amount, while in 1949, construction will be increased to provide 30,000 kw additional, and by 1951, another 20,000 kw will be made available. New power substations will be built and extensions made in transmission lines.

Texas, Beaumont—Gulf States Utilities Co., Beaumont, will make extensions in power plants during next 36 months to increase present capacity by about 75 per cent. Program will be carried out at different stations and will include additional power substations, switching stations, transmission and distributing lines, and other operating facilities. Cost estimated close to $50,000,000 for entire development during period noted.

Va., Tangier—Chesapeake Island Electric Cooperative, Tangier, plans installation of new steam-electric generating station, reported to cost close to $185,000. Financing will be arranged through Federal aid.

Wis., Clear Lake—Wisconsin Hydro Electric Co., Amery, Wis., has approved plans for new addition to oil engine-operated generating station at Clear Lake, with installation of equipment for increased capacity. Work will begin at early date. No estimate of cost announced.

Wis., Stratford—Whitehouse Milk Co., Manitowoc, Wis., milk and dairy products, plans new boiler house at plant at Stratford, 25x42 ft. No estimate of cost announced. G. A. Krasin, Marshfield, Wis., is architect.